ENHANCED IN SITU BIOREMEDIATION PILOT STUDY REPORT

OMC PLANT 2
Waukegan, Illinois

Remedial Investigation/Feasibility Study

WA No. 018-RICO-0528/Contract No. EP-S5-06-01

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Acronyms and Abbreviations

µs	microsiemen
µg/L	micrograms per liter
bgs	below ground surface
CLP	Contract Laboratory Program
cis-1,2-DCE	cis-1,2-dichloroethene
cm/sec	centimeters per second
CVOC	chlorinated volatile organic compound
DCE	dichloroethene
DNAPL	dense nonaqueous phase liquid
DO	dissolved oxygen
DPT	direct-push technology
ECD	electron capture device
EISB	enhanced in situ bioremediation
EOS™	emulsified oil substrate
ERD	enhanced reductive dechlorination
FS	feasibility study
ft^2	square foot
ft/ft	foot per foot
IEPA	Illinois Environmental Protection Agency
LNAPL	light nonaqueous phase liquid
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MIP	membrane interface probe
NAPL	nonaqueous phase liquid
O&M	operation and maintenance
OMC	Outboard Marine Corporation
ORP	oxidation-reduction potential

OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PID	photoionization detector
PVC	polyvinyl chloride
Rf	retardation factor
RI	remedial investigation
TCE	trichloroethene
TOC	total organic carbon
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VFA	volatile fatty acids
VOC	volatile organic compound
ZVI	zero-valent iron

SECTION 1

Introduction

This report presents the approach and results of the enhanced in situ bioremediation (EISB) pilot test conducted as part of the remedial investigation (RI)/feasibility study (FS) at the Outboard Marine Corporation (OMC) Plant 2 site in Waukegan, Illinois. The work was performed for the U.S. Environmental Protection Agency (USEPA) in accordance with the statement of work for Work Assignment No. 018-RICO-0528.

The evaluation of viable groundwater remediation technologies during the FS identified two in situ treatment technologies to address the dense nonaqueous phase liquid (DNAPL) and groundwater source zones and the resulting groundwater plume. This report discusses the approach and findings of the pilot test developed to determine whether EISB technologies would effectively treat the groundwater source zones. The activities related to in situ treatment of the DNAPL source zones are presented in the *Data Evaluation Summary Report* (CH2M HILL, 2008).

This EISB pilot test report contains the following components:

- Section 1 provides a general description of the site background and an overview of the pilot test activities and objectives.
- Section 2 describes the design, implementation, and performance of EISB testing at Groundwater Source Area 4.
- Section 3 describes the design, implementation, and performance of EISB testing at Groundwater Source Area 5.
- Section 4 presents the conclusions and recommendations.
- Section 5 provides the references cited in this report.
- Appendix A contains a memorandum describing the field activities related to the implementation of the EISB pilot test.
- Appendix B contains summaries of the post-injection monitoring results at each well location.
- Appendix C contains graphs of results for individual wells.

1.1 Project Background

This section provides a brief summary of the project background. Detailed discussions of the site history and physical and chemical characteristics are presented in the RI report (CH2M HILL, 2006b), the FS report (CH2M HILL, 2006a), and the *Data Evaluation Summary Report* (CH2M HILL, 2008).

The OMC Plant 2 site is located at 100 East Seahorse Drive, Waukegan, Illinois, and is the fourth operable unit (OU) of the OMC National Priorities List site. The 65-acre site included a 1,036,000-square foot (ft^2) former manufacturing plant building (that is, Plant 2) and several parking lot areas to the north and south of the building complex (Figure 1-1). In 2006, the City of Waukegan demolished portions of the plant building (approximately 400,000 ft^2), including the trim building, the new die cast area, and the corporate building, to their slabs. The site includes two polychlorinated biphenyl (PCB) containment cells in which PCB-contaminated sediment (dredged from the Waukegan Harbor in the early 1990s) and PCB-impacted soil are managed. The cells (the "East Containment Cell" and "West Containment Cell") are located north of Plant 2. OMC performed the harbor dredging work under a 1988 consent decree with USEPA and the Illinois Environmental Protection Agency (IEPA) that also required long-term operations and maintenance (O&M) of the containment cells.

OMC designed, manufactured, and sold outboard marine engines, parts, and accessories to a worldwide market for many years. OMC Plant 2 was a main manufacturing facility for OMC—the major production lines used PCB-containing hydraulic and lubricating/cutting oils, chlorinated solvent-containing degreasing equipment, and smaller amounts of hydrofluoric acid, mercury, chromic acid, and other similar chemical compounds.

OMC filed for bankruptcy protection on December 22, 2000, and later abandoned the property after completing a limited removal action under USEPA oversight. In November 2001, the bankruptcy trustee filed a motion to abandon OMC Plant 2. USEPA conducted a site discovery inspection in spring 2002 to document the presence of numerous chemical compounds in OMC Plant 2 and support the allegation of imminent and substantial endangerment. Based on the findings, USEPA and the State of Illinois filed a joint objection to the abandonment and alleged that the site posed an imminent and substantial endangerment to public health and welfare and the environment. The bankruptcy trustee negotiated an emergency removal action scope of work with USEPA and IEPA that the court approved on July 17, 2002. The waste removal activities for the OMC Trust were completed in November 2002 and the Trust abandoned the OMC Plant 2 property on December 10, 2002.

USEPA assumed control of building security and utilities on December 10, 2002, and conducted further removal actions to clean up more of OMC Plant 2 in spring 2003. USEPA maintained electrical power to support O&M of the PCB containment cells until December 10, 2003, after which time, the State took over O&M of the cells.

The RI field investigation was conducted between January and June 2005 and identified the following potential environmental problems (CH2M HILL, 2006b):

- PCB-contaminated concrete floors, walls, and ceilings exist in the old die cast, parts storage, and metal working areas.
- Soil beneath the northern and southern parking lot areas and east of the plant contain PCB and/or polynuclear aromatic hydrocarbons (PAHs) at levels that exceed their respective preliminary cleanup goals.
- Chlorinated solvents in substantial quantities, including a trichloroethene (TCE) DNAPL pool, exist beneath the site.

- A chlorinated solvent groundwater plume is potentially migrating into Lake Michigan or to Waukegan Harbor.

Based on the data collected, potential alternatives were developed and evaluated in the FS report to address the contaminated building materials, soil and sediment, and groundwater and DNAPL (CH2M HILL, 2006a). In December 2006, USEPA issued a proposed plan for the cleanup of contaminated building materials, soil, and sediment and indicated that the remedy for groundwater and DNAPL would be identified after a pilot-scale study evaluation of possible cleanup methods is completed.

1.2 Overview of the Pilot Test Activities

The FS report identified two in situ treatment technologies (chemical reduction in the DNAPL source zones and EISB in the groundwater source zones) as viable response actions to address the source zones and the resulting groundwater plume of chlorinated volatile organic compounds (CVOCs). A pilot test approach was developed to determine whether the in situ technologies could be used as a major component of the groundwater remedy and how the selected in situ technology would be implemented full scale at the site.

The pilot test activities related to treatment of the DNAPL are presented in the *Data Evaluation Summary Report* (CH2M HILL, 2008). The EISB pilot test activities are summarized below.

1.2.1 Groundwater Source Zones

The results of the RI indicate that the groundwater contamination is related to the use of chlorinated solvents, primarily TCE, in past manufacturing operations at OMC Plant 2. Data indicate that the chlorinated "parent compound" in groundwater (TCE) was released to the subsurface during manufacturing operations and created "source zones." Source zones are defined as portions of the aquifer that have particularly high dissolved phase TCE concentrations, and which may have residual DNAPL or high concentrations of adsorbed TCE that can continue to create and sustain dissolved phase plumes.

Based on the findings of the membrane interface probe (MIP), soil, and groundwater investigations and the conceptual site model, five source zones were identified in the FS report (CH2M HILL, 2006a). Two of the five source zones, Areas 4 and 5, are being targeted by the EISB pilot test in an attempt to reduce the mass of TCE and contributions to the downgradient groundwater plume (Figure 1-2). Originally, Area 2 was to be included in the pilot test; however, extensive TCE DNAPL was identified in Area 2. To prevent the DNAPL from negatively impacting the apparent effectiveness of one amendment, Area 5 replaced Area 2 in the pilot test.

1.2.2 Pilot Test Objectives

Based on the selected treatment areas and the in situ remedial technologies identified for the source zones and groundwater plume, the overall objectives for the EISB pilot test of the source zones are as follows:

1) Evaluate the degree to which in situ treatment through substrate injection can reduce the concentrations of TCE and degradation products (cis-1,2-dichloroethene [cis-1,2-DCE]

and vinyl chloride) in the target treatment source zones and downgradient monitoring locations.

2) Determine the overall effectiveness of in situ treatment for achieving complete reduction of TCE to nontoxic degradation products (such as ethene or ethane).

3) Monitor the duration that the injected substrates can maintain enhanced, relative to background, reducing conditions for in situ treatment.

4) Determine the radius of influence of the selected injection method.

An additional objective of the pilot test is to examine the effectiveness of two different amendments—a soluble substrate (such as sodium lactate) and an edible oil substrate (EOS™). The RI data indicate that TCE is being degraded by naturally occurring bacteria (via reductive dechlorination) to transformation products (1,2-DCE and vinyl chloride). Because of the degree that TCE is being naturally degraded, EISB amendments were selected to further stimulate the natural processes.

Subsurface conditions at the selected groundwater source areas did not support selection of one EISB amendment over others. Two substrates were selected to determine if site-specific subsurface conditions would impact effectiveness of either substrate to enhance bioremediation. The amendments selected for injection included Edible Oil Substrate (EOS™) and a soluble substrate (sodium lactate).

1.2.3 EISB Activities

The pilot test activities were implemented in accordance with the USEPA-approved *Supplemental Field Sampling Plan* (CH2M HILL, 2006c) and the *Supplemental Quality Assurance Project Plan* (CH2M HILL, 2007). Additional information on the development of the pilot test approach, including possible treatment areas, types of amendments, and costs, are presented in the *OMC Plant 2 (OU#4) Groundwater Treatment Pilot Study* memorandum (CH2M HILL, 2006).

The pilot test included the following activities:

1. Injection well and monitoring well installation (including baseline groundwater sampling and analysis).
2. Injection of the amendment.
3. Post-injection performance monitoring (secondary and primary).
4. Follow-up injections, as needed.

SECTION 2

Source Area 4

This section summarizes activities associated with the implementation of the EISB pilot test in Area 4. A description of the field activities is summarized in the well injection pilot test memorandum provided in Appendix A.

2.1 Description of Source Area 4

Area 4 is approximately 18,000 ft² located south of the existing building in an unpaved grassy area east of the former corporate building (Figure 2-1). The RI indicated the presence of TCE in shallow and deep groundwater in the area. Depth to water in the area is approximately 3 feet below ground surface (bgs) with an aquifer thickness of nearly 30 feet. Area 4 aquifer properties are summarized in Table 2-1.

TABLE 2-1
Area 4 Aquifer Properties
OMC Plant 2

Aquifer Interval	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (cm/sec)	Soil Bulk Density (lbs/ft^3)	Total Porosity (SU)	Total Effective Porosity (SU)
Shallow	0.002	2.16×10^{-2}	118.125	0.3	0.17
Deep	0.0008	4.56×10^{-3}	100.625	0.3	0.17

Note:

ft/ft = feet per foot
cm/sec = centimeters per second
lbs/ft^3 = pounds per cubic foot
SU = standard unit

2.2 EISB Amendment Selection

Sodium lactate is nearly 100 percent soluble when dissolved in water. The sodium lactate stimulates reductive dechlorination as the substrate ferments; it releases hydrogen gas and acetate, which are used as the electron donor by the microbes.

The short longevity of sodium lactate, relative to EOS™, requires that sodium lactate be injected during quarterly events. The schedule of the pilot study permitted four injection events.

2.3 Injection Well System

2.3.1 Amendment Injection Array

The lines of injection wells were spaced in Area 4 based on an estimated travel time between lines of injection wells of 2 years for the shallow wells and 3 years for the deep wells. Estimated travel times were based on groundwater velocities estimated from aquifer

properties measured during the RI. Because of the slower groundwater velocity and higher concentrations of contaminants observed in the deep zone, more injection wells were installed in the deep zone compared to the shallow zone.

Area-specific hydrogeologic properties, contaminant concentrations, biogeochemical data, well installation costs, labor costs, and properties of sodium lactate were used as inputs to the injection design for Area 4. Using these parameters, injection well spacing and injection frequency were optimized to achieve the highest percentage of treatment while minimizing the number of injection wells and, indirectly, labor and material costs.

The injection well array in Area 4 includes a total of 20 injection wells (5 shallow wells and 15 deep wells) arranged in 4 parallel rows (3 rows of deep wells and 1 row of shallow wells) (Figure 2-2). The rows are oriented west to east, perpendicular to the north to south groundwater flow direction (Figures 2-3 and 2-4). Each row of deep wells is spaced approximately 30 feet apart, with 5 wells per row, with 25 feet between each well. The one row of shallow wells is located north of the northern row of deep wells. The shallow wells are spaced approximately 30 feet apart within the line. Because the spacing between the shallow injection well lines would exceed the length of Area 4 (north to south), there is only one line of shallow injection wells. The injection layout installed for the pilot test for Area 4 is summarized in Table 2-2.

TABLE 2-2
Summary of Area 4 Injection System
OMC Plant 2

Area	Treatment Depth[a]	Screened Interval (ft bgs)	Injection Well Spacing (ft)	Number of Injection Wells Per Barrier	Barrier Spacing (ft)	Number of Barriers	Total Number of Wells
Area 4	Deep	22.0 – 27.0*	32	5	28	3	15
	Shallow	9.5 – 14.5	28	5	95	1	5

Notes:

[a]Depths refer to the following:
Shallow = Injection wells installed to a depth of approximately 15 feet
Deep = Injection wells installed to the base of the aquifer, a depth of approximately 30 feet

Deep injection well screened intervals are approximate. The base of the screen is set 6 inches above the base of the aquifer which varies in elevation across the site.

2.3.2 Injection Well Design

The design was the same for Area 4 and Area 5 injection wells. Well construction materials consisted of 2-inch diameter, schedule 40 poly-vinyl chloride (PVC) risers with 5-foot-long, 2-inch-diameter, 0.010-inch slot, continuously wire-wrapped stainless-steel screens. A summary of injection well construction details is presented in the Hydrogeologic Investigation attachment to the *Data Evaluation Summary Report* (CH2M HILL, 2008).

Five-foot well screens were used to reduce the potential for preferential flow of the injected solution into small high permeability zones within the aquifer and to provide more homogeneous distribution within the aquifer. The continuously wire-wrapped screens also provide more open area for injection than slotted PVC screens allowing increased injection rates at lower injection pressures.

2.3.3 Injection

An injection system manifold was constructed to mix the substrate and clean water and to deliver the solution to each of the wells. This system allowed for the injection of up to eight wells simultaneously. The flow meters were used to measure the flow rate and gallons of solution to each well. Details regarding the injection system manifold and the injections are provided in Appendix A. A summary of the injections performed in Area 4 is summarized in Table 2-3.

TABLE 2-3
Area 4 Sodium Lactate Injections Summary
OMC Plant 2

Injection Date	Depth Interval	Sodium Lactate Injected Per Well Per Injection (gal)	Total Water Injected Per Well Per Injection (gal)	Sodium Lactate Solution Concentration (%)
March 12, 2007	Shallow	12	2,235	0.53
	Deep	16	3,105	0.53
June 13, 2007	Shallow	12	2,235	0.53
	Deep	16	3,105	0.53
September 17, 2007	Shallow	12	2,235	0.53
	Deep	16	3,105	0.53
January 8, 2008[a]	Shallow	12	387	3.1
	Deep	16	537	3.1

Note:
[a]During the fourth event, only 10,000 gallons of water was available for injection. In this case, substrate was injected at a 3 percent concentration, for a total solution injection of 10,300 gallons.

2.4 Performance Monitoring

EISB implementation began in February 2007 with a site-wide groundwater sampling event. Groundwater samples were collected prior to injection to provide a snapshot of baseline (pre-injection) groundwater quality. The results from the baseline sampling event are discussed in the *Data Evaluation Summary Report* (CH2M HILL, 2008). Following the initial injection, groundwater sampling events were conducted to quantify changes in groundwater geochemistry and contaminant concentrations. Baseline and performance monitoring groundwater samples were collected using low-flow purge techniques.

2.4.1 Monitoring Well Layout

The existing groundwater monitoring well network was supplemented with additional shallow and deep monitoring wells in the treatment areas (Figure 2-1) prior to baseline sampling. The new monitoring wells were added to provide performance monitoring data from upgradient, downgradient, and/or within the treatment zone. Monitoring well locations were selected to be close enough to the treatment areas to allow water from the treatment zone to reach the well within the schedule of the pilot study (10 months). Groundwater velocities developed during the RI were used to determine the appropriate distances.

Monitoring wells were installed in pairs with one screened in the shallow interval and the other in the deep interval. Area 4 shallow monitoring wells were installed with the base of the screened interval at a depth of 10.5 feet bgs, intersecting the water table. Deep monitoring wells were installed with the bottom of the screen at the base of the aquifer. Both shallow and deep monitoring wells were constructed with 5-foot-long, 2-inch-diameter, 0.010-inch slot PVC well screens. Details on the monitoring well construction are presented in the Hydrogeologic Investigation attachment to the *Data Evaluation Summary Report* (CH2M HILL, 2008).

2.4.2 Area 4 Performance Monitoring Results

The primary performance monitoring events included analyses of the parameters listed in Table 2-4. The secondary performance monitoring events only include analyses for field parameters (oxidation-reduction potential [ORP], pH, dissolved oxygen [DO], temperature, turbidity, and conductivity) and total organic carbon (TOC). Field parameters were collected during well purging using field instruments.

TABLE 2-4
EISB Pilot Test Primary Monitoring Event Analytical Parameters
OMC Plant 2

Alkalinity	Nitrate/Nitrite	Volatile Organic Compounds (VOCs)	Chloride
Ferrous Iron	Dissolved Manganese	Sulfate/Sulfide	Methane
Ethane/Ethene	Volatile Fatty Acids(VFAs)	Total Organic Carbon (TOC)	

Analytical results for performance monitoring are presented in Appendix B. Graphs of results for individual wells are presented in Appendix C.

EISB is designed to bring about a decrease in VOC concentrations in groundwater. However, the reductive dechlorination of TCE generates daughter products cis-1,2-DCE and vinyl chloride. As a result, increases in the concentrations of cis-1,2-DCE and vinyl chloride are anticipated during the pilot test and are indicative of effective EISB.

In Area 4, the well pair, MW-528S/D, was designated as background wells because they are located outside the treatment area. Changes in performance monitoring parameters were evaluated against MW-528S/D to determine if the changes were a result of the sodium lactate injections or other subsurface conditions.

2.4.3 Results for MW-514S

MW-514S is located approximately 80 feet south (downgradient) of the shallow injection well barrier (Figure 2-2). Baseline TCE concentrations (1.2 milligrams per liter [mg/L]) decreased during the pilot test to 0.86 mg/L in December. Decreases in TCE concentrations were accompanied by increases in concentrations of cis-1,2-DCE and vinyl chloride characteristic of enhanced reductive dechlorination (ERD) of TCE. Concentrations of TOC in MW-514S did not increase over baseline sampling indicating the injected sodium lactate did not migrate to MW-514S over the duration of the pilot test.

The concentrations of the various natural attenuation parameters from MW-514S indicate reducing conditions exist, however, the enhancement of reducing conditions is occurring primarily upgradient of MW-514S. Chloride concentrations have increased from a baseline concentration of 77 mg/L to 130 mg/L in December. However, ethane and ethene were not detected (<0.001 mg/L) in December, and showed an overall decrease from baseline concentrations of 0.039 mg /L and 0.0056 mg/L, respectively. High sulfate concentrations (88 mg/L) were measured at MW-514S and no dissolved iron was detected.

Measurement of field parameters showed fluctuations in DO (including concentrations greater than 1.0 mg/L and ORP (values between positive and negative values), and gradually increasing specific conductance. These conditions are indicative of reducing conditions with little to no enhancement from the pilot study injections.

In summary, it appears that reductive dechlorination in the shallow groundwater of the treatment area upgradient of this monitoring well is occurring. However, given the estimated travel time of 12 to 24 months from the injection line to this monitoring well, it is expected that the full effects of the treatment are only just beginning to appear at this monitoring location.

2.4.4 Results for MW-527S

MW-527S is located approximately 70 feet south (downgradient) of the shallow injection well barrier in Area 4. Following the injection of sodium lactate, TCE concentrations declined from 0.73 mg/L to 0.61 mg/L in December. Concentrations of cis-1,2-DCE increased from a baseline concentration of 0.54 mg/L to 3.2 mg/L in December. Vinyl chloride concentrations also increased during the pilot test from a baseline concentration of 0.49 mg/L to 1.8 mg/L in December.

Natural attenuation parameters indicate shallow groundwater conditions in Area 4 are less favorable for EISB than conditions in the deep groundwater. High concentrations of nitrate (7.5 mg/L) were measured in MW-527S. The nitrate concentration may be due to residual lawn fertilizers leaching to groundwater. Dissolved iron and ethene were not detected in MW-527S; however, ethane was detected with concentrations increasing during the pilot test.

Field parameters also indicate that reducing conditions in Area 4 shallow groundwater are not as indicative of EISB as conditions in the deep groundwater. DO concentrations generally remained less than 1 mg/L while ORP values fluctuated between -220 millivolts (mV) and 111 mV.

In summary, it appears that reductive dechlorination in the shallow groundwater of the treatment area upgradient of this monitoring well is occurring. It appears though that the degree of biological degradation is being slowed by the presence of nitrate that must first be depleted before reductive dechlorination of the CVOCs proceeds. Given the estimated 12 to 24 months for the substrate to distribute across the treatment zone, it may be that greater reductive dechlorination has already occurred upgradient of this location and has yet to be monitored.

2.4.5 Results for MW-529S

MW-529S is located inline with the shallow injection wells along the northern (upgradient) edge of Area 4 approximately 15 feet from an injection well (Figure 2-2). Overall, concentrations of TCE, cis-1,2-DCE, and vinyl chloride increased during the pilot study.

Generally, natural attenuation parameters indicate reducing conditions are less favorable in Area 4 shallow groundwater than deep groundwater. Nitrate concentrations up to 13 mg/L were detected in September. These concentrations may be related to residual fertilizer leaching into the shallow groundwater. In addition, dissolved iron was not detected and concentrations of ethane and ethene decreased during the pilot study. TOC concentrations did increase from a baseline concentration of 2 mg/L to 220 mg/L in November indicating the sodium lactate solution has migrated to MW-529S.

Field parameter readings also indicate conditions are less conducive to ERD in Area 4 shallow groundwater. DO concentrations were generally at or above 1 mg/L while ORP values measured during the pilot study were generally above baseline measurements.

In summary, it appears that reductive dechlorination in the shallow groundwater of the treatment area at MW-514S is occurring. Elevated TOC concentrations were detected indicating the arrival of sodium lactate; however, it appears the degree of biological degradation is being slowed by the presence of nitrate that must first be depleted before reductive dechlorination of the CVOCs proceeds.

2.4.6 Results for MW-514D

MW-514D is located approximately 20 feet south (downgradient) of the southernmost deep injection barrier line in Area 4. Performance monitoring data collected from MW-514D provides strong evidence of EISB. Baseline TCE concentrations (0.5 mg/L) decreased during the pilot study to less than 0.001 mg/L in December. Concentrations of cis-1,2-DCE increased to 4.3 mg/L in September from a baseline concentration of 2.3 mg/L before decreasing in December to 1.9 mg/L. Vinyl chloride concentrations also increased in September to 7.3 mg/L from baseline concentrations of 1.7 mg/L before decreasing in December to 5.5 mg/L. Baseline TOC concentrations (5 mg/L) increased to 150 mg/L in September and 170 mg/L in December indicating sodium lactate had migrated to MW-514D.

Natural attenuation parameter results for MW-514D also indicate enhanced reducing conditions are being generated as a result of the injections. Increases over the baseline of dissolved iron, ethene, alkalinity, and VFAs, indicative of EISB, were measured during the pilot test.

Field parameters confirm the enhanced reducing conditions indicated by the natural attenuation parameters and CVOC concentrations. DO concentrations remained less than 1 mg/L, ORP measurements decreased, and specific conductance increased indicating the presence of the sodium lactate solution.

In summary, there is strong evidence that reductive dechlorination in the deep groundwater at MW-514D is occurring and is related to the arrival of the sodium lactate solution. The reducing conditions in the Area 4 deep groundwater are stronger than those detected in the shallow groundwater at the same location.

2.4.7 Results for MW-527D

MW-527D is located inline with the southernmost (downgradient) line of deep injection wells. Performance monitoring data collected from MW-527D provides strong evidence of EISB. Baseline TCE concentrations (0.630 mg/L) decreased to less than 0.001 mg/L in December. Similarly, baseline concentrations of cis-1,2-DCE (8.0 mg/L) decreased to 0.003 mg/L in December. Baseline vinyl chloride concentrations (4.3 mg/L) increased to 5.1 mg/L in June before declining to 0.058 mg/L in December.

Decreases in VOC concentrations at MW-527D correlate with changes in the natural attenuation parameters. TOC concentrations increased from a baseline of 6 mg/L to 850 mg/L in December. Corresponding increases in acetic acid concentrations were measured with December concentrations reaching 960 mg/L from a baseline concentration of less than 0.005 mg/L. Increasing alkalinity along with concentrations of dissolved iron and manganese over baseline conditions also indicate an enhancement of the reducing conditions.

Field parameter measurements further support the enhanced reducing conditions at MW-527D. ORP measurements decreased from a baseline value of -114 mV to their lowest measurement of -283 mV in May and increased slightly to -170 mV in December. Increases in specific conductance values to 3,587 microseconds (µs) per centimeter (cm) in December from a baseline value of 2,499 µs/cm confirm the presence of the sodium lactate solution.

2.4.8 Results for MW-529D

MW-529D is located inline with the northernmost (upgradient) line of deep injection wells approximately 10 feet east of a deep injection well (Figure 2-2). Performance monitoring data collected from MW-529D provides strong evidence of EISB. Baseline TCE concentrations, 0.099 mg/L, declined to greater than 0.001 mg/L. Concentrations of cis-1,2-DCE declined from a baseline concentration of 1.7 mg/L to 0.72 mg/L in December. Vinyl chloride concentrations increased to 2.5 mg/L in June from a baseline concentration of 1.5 mg/L before declining to 1.6 mg/L in December.

Natural attenuation parameters also indicate reducing conditions have been enhanced at MW-529D. Post-injection concentrations of propionic acid increased to 500 mg/L in December and were not detected in baseline samples. In contrast to the shallow groundwater, nitrate concentrations remained below 1.0 mg/L during the pilot study. Dissolved iron and manganese concentrations fluctuated during the pilot test, but generally remained consistent with baseline concentrations.

Field parameters indicate reducing conditions have been enhanced as a result of sodium lactate injections. ORP values have significantly decreased from baseline measurements of -96 mV to -403 mV. DO concentrations have fluctuated during the pilot test while specific conductance measurements have remained generally consistent with baseline measurements.

SECTION 3

Source Area 5

This section summarizes activities associated with the implementation of the EISB pilot test in Area 5. A complete description of the field activities is summarized in the well injection pilot test memorandum provided in Appendix A.

3.1 Description of Source Area 5

Area 5 is approximately 38,000 ft² located beneath the northwest portion of the existing building (Figure 2-1). The RI indicated the presence of elevated TCE concentrations in deep groundwater in the area. Depth to groundwater in Area 5 is approximately 8 feet bgs and the aquifer thickness is nearly 30 feet. Area 5 aquifer properties are summarized in Table 3-1. EOS™ treatment was selected for use in Area 2 and was carried over to Area 5 due to the presence of TCE DNAPL in Area 2.

TABLE 3-1
Area 5 Aquifer Properties
OMC Plant 2

Aquifer Interval	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (cm/sec)	Soil Bulk Density (lbs/ft^3)	Total Porosity (SU)	Total Effective Porosity (SU)
Shallow	0.002	2.16×10^{-2}	90.625	0.3	0.17
Deep	0.0008	4.56×10^{-3}	91.25	0.3	0.17

3.2 EISB Amendment Selection

EOS™ is a patented emulsified oil product that consists primarily of emulsified soybean oil with lesser amounts of lactate and micronutrients. Following injection, the vegetable oil dissolves into groundwater over time (several years), biodegrades to VFAs, and releases hydrogen to support biological reductive dechlorination of the CVOCs. The extended period of dissolution allowed the pilot test to be completed using only one injection of EOS™.

3.3 Injection Well System

3.3.1 Amendment Injection Array

Lines of injection wells were spaced in both Areas 4 and Area 5 based on an estimated travel time of 2 years for the shallow wells and 3 years for the deep wells (Figure 3-1). Estimated travel times were based on groundwater velocities estimated from aquifer properties

measured during the RI. Because of the slower groundwater velocity and higher concentrations of contaminants observed in the deep zone, more injection wells were installed in the deep zone compared to the shallow zone.

The injection well array in Area 5 includes 38 injection wells arranged in 5 parallel rows or fences (3 rows of deep wells and 2 rows of shallow wells). Of these 38 wells, 13 were installed as shallow wells, and 25 were installed as deep wells. The rows are oriented southwest to northeast, perpendicular to the northwest to southeast groundwater flow direction (Figures 2-3 and 2-4). The spacing between the rows of deep wells is approximately 56 feet apart. Only one row of shallow wells was used for the pilot injection of EOS™, and it is located in the approximate center of Area 5. The second shallow row (Wells IW-500, IW-501, IW-502, and IW-503), located in the northwestern portion of section of Area 5, was not utilized for injection. These wells were not utilized for injection because no shallow monitoring well was able to be installed downgradient due to obstructions within the distance groundwater is estimated to travel in 1 year. Without a monitoring well within the estimated treatment radius of these injection wells, no data would be available on their effectiveness limiting their usefulness for the pilot test. Should the pilot study be expanded to full-scale treatment, the wells will be utilized.

In Area 5, both shallow and deep wells in each row were installed with a spacing of approximately 22.5 feet between wells. This well spacing resulted in a row of 9 shallow wells and 3 rows of 6, 9, and 10 deep wells. The row and well spacings were calculated based on a cost-benefit analysis. The cost-benefit analysis weighed the estimated injection radius of influence, estimated groundwater velocities, the cost of well installation and re-injection events to estimate effective injection well and row spacing.

The injection layout installed for the Area 5 pilot test is summarized in Table 3-2.

TABLE 3-2
Summary of Area 5 Injection System and Parameters
OMC Plant 2

Area	Treatment Depth[a]	Screened Interval (ft bgs)	Injection Well Spacing (ft)	Number of Injection Wells Per Barrier	Barrier Spacing (ft)	Number of Barriers	Total Number of Wells
Area 5	Deep	21.0 – 26.0[b]	22.5	6, 9, 10	56	3	25
	Shallow	9.5 – 14.5	22.5	9	286	1	9

[a]Depths refer to the following:
Shallow = Injection wells installed to a depth of approximately 15 feet
Deep = Injection wells installed to the base of the aquifer, a depth of approximately 30 feet
[b]Deep injection well screened intervals are approximate. The base of the screen is set 6 inches above the base of the aquifer which varies in elevation across the site.

Injection Well Design

The injection well design used for Area 5 is identical to that used in Area 4. A summary of the Area 5 injection well construction details is presented in the Hydrogeologic Investigation attachment to the *Data Evaluation Summary Report* (CH2M HILL, 2008).

Injection

The manifold injection system used to inject the sodium lactate solution in Area 4 was also used to inject the EOS™ in Area 5. A single injection of EOS™ was conducted on March 23, 2007. The EOS™ injection is summarized in Table 3-3. No additional injections of EOS™ were required due to the lasting effects of one injection (up to 3 years). Details regarding concentrations and injection volumes are included in Appendix A.

TABLE 3-3
Area 5 EOS™ Injection Summary
OMC Plant 2

Injection Date	Depth Interval	EOS™ Injected Per Well Per Injection (gal)	Total Water Injected Per Well Per Injection (gal)	EOS™ Solution Concentration (%)
March 23, 2007	Shallow	24	1,240	1.9
	Deep	48	2,480	1.9

3.4 Performance Monitoring

As noted in Section 2, EISB implementation began in February 2007 with a site-wide groundwater sampling event to provide a snapshot of baseline (pre-injection) groundwater quality. The results from the baseline sampling event are presented and discussed in the *Data Evaluation Summary Report* (CH2M HILL, 2008). Following the initial injection, groundwater sampling events were conducted to quantify changes in groundwater geochemistry and contaminant concentrations. Groundwater samples were collected using low-flow purge techniques.

3.4.1 Monitoring Well Layout

The existing groundwater monitoring well network was supplemented with additional shallow and deep monitoring wells in the treatment areas (Figure 2-1) prior to baseline sampling. The new monitoring wells were added to provide performance monitoring data from upgradient, downgradient, and/or within the treatment zone. Monitoring well locations were selected to be close enough to the treatment areas to allow water from the treatment zone to reach the well within the schedule of the pilot study (10 months). Groundwater velocities developed during the RI were used to determine the appropriate distances.

Monitoring wells were installed in pairs with one screened in the shallow interval and one in the deep interval. Area 5 monitoring well screened intervals were set to the same general depth below ground surface as the injection wells. Deep monitoring well screened intervals may vary due to the varying elevation of the aquifer base/till unit surface. Details on the monitoring well construction are presented in the Hydrogeologic Investigation attachment to the *Data Evaluation Summary Report* (CH2M HILL, 2008).

3.4.2 Area 5 Performance Monitoring Results

The primary performance monitoring events included analyses of the parameters listed in Table 2-3. The secondary performance monitoring events only include analyses for field parameters (ORP, pH, DO, temperature, turbidity, and conductivity) and TOC. Field parameters were collected during well purging using field instruments.

Analytical results for performance monitoring are presented in Appendix B. Graphs of results for individual wells are presented in Appendix C.

3.4.3 Results for MW-505S

MW-505S is located approximately in the middle of Area 5 approximately 7 feet southeast (downgradient) of a shallow injection well. Baseline TCE, cis-1,2-DCE, and vinyl chloride concentrations were below detection limits (less than 0.001 mg/L) and remained below detection limits during the pilot test.

Natural attenuation parameters indicate reducing conditions occur at MW-505S. Dissolved manganese concentrations in Area 5 shallow monitoring wells were highest at MW-505S. Significant baseline concentrations of dissolved iron (11.5 mg/L) and low sulfate concentrations (3 mg/L) have remained consistent during the pilot study and are indicative of reducing conditions. As a result of the injections, TOC concentrations increased from a baseline concentration of 3 mg/L to a maximum of 12 mg/L in May and fluctuating between 6 mg/L and 11 mg/L for the duration of the pilot test. Field parameter measurements indicate DO concentrations less than or near 1 mg/L and negative ORP values, again indicative of reducing conditions.

In summary, sampling results indicate reducing conditions are present at MW-505S. Small increases in TOC concentrations have occurred and are likely related to the injections in Area 5; however, analytical results and field parameters have shown little change following the injections.

3.4.4 Results for MW-520S

MW-520S is located approximately 120 feet southeast (downgradient) of the shallow injection well line. Following injection of EOS™, the baseline TCE concentrations (0.004 mg/L) declined to 0.002 mg/L. Cis-1,2-DCE concentrations detected downgradient at MW-520S increased from a baseline of 0.009 mg/L to 2.3 mg/L in June before declining to 0.22 mg/L in September and 0.15 mg/L in December. This data indicates some displacement of the more concentrated portion of the plume likely occurred. Vinyl chloride concentration also increased to 0.490 mg/L in September before decreasing to 0.055 mg/L in December.

Natural attenuation parameters indicate that reducing conditions at MW-520S were enhanced by the injection of EOS™. A significant increase in TOC concentrations to 19 mg/L from a baseline concentration of 3 mg/L occurred at this location. In addition, concentrations of ethene detected in MW-520S (0.180 mg/L) were the highest detected in Area 5 shallow groundwater and were approximately 20 times the concentration detected in upgradient location MW-519S. Baseline VFAs were below detection limits in MW-520S. Acetic acid was detected at 47 mg/L in September and at 18 mg/L in December.

Field parameters also indicate enhanced reducing conditions at MW-520S following injection of EOS™. ORP measurements decreased from baseline values of -90 mV to -200 mV in November with DO levels remaining at or below 1 mg/L.

3.4.5 Results for MW-521S

MW-521S is located southeast (downgradient) of Area 5 approximately 120 feet downgradient of the shallow injection well line. TCE was not detected in groundwater samples collected from MW-521S during the pilot test. Cis-1,2-DCE concentrations decreased from baseline concentration of 0.016 mg/L to less than 0.0004 mg/L in December. Baseline vinyl chloride concentrations of 0.026 mg/L increased to 0.099 mg/L in June before decreasing to less than 0.001 mg/L in December.

Natural attenuation parameters indicate enhanced reducing conditions, relative to baseline, at MW-521S. Baseline TOC concentration (0.7 mg/L) increased to 29 mg/L in June and September before decreasing to 3.1 mg/L in December. Substantial decreases in sulfate concentrations were measured in MW-521S while other shallow monitoring wells generally showed increased sulfate concentrations. Sulfate decreased from a baseline concentration of 120 mg/L to 6 mg/L in June and 32 mg/L in December. Chloride concentrations in MW-521S increased from baseline measurements of 370 mg/L, increased to 470 mg/L in September, and declined to 400 mg/L in December. No VFAs were detected in baseline sampling; however, 100 mg/L of acetic acid were detected at MW-521S in September.

Field parameter measurements at MW-521S indicate reducing conditions enhanced by injection of EOS™. DO levels generally remained less than 1 mg/L during the pilot test, consistent with background concentrations. ORP measurements decreased from a baseline of -78 mV to -166 mV in December with a low of -229 mV in September.

3.4.6 Results for MW-522S

MW-522S is located approximately 20 feet downgradient of the shallow injection well line. TCE concentrations decreased at MW-522S from a baseline concentration of 0.003 mg/L to less than 0.001 mg/L in December. Baseline concentrations of cis-1,2-DCE (0.058 mg/L) increased to 1.2 mg/L in December. Vinyl chloride concentrations increased from a baseline concentration of 0.092 mg/L to 1.5 mg/L in September before declining to 0.4 mg/L in December.

Natural attenuation parameters indicate reducing conditions are present at MW-522S but show little enhancement during the pilot test. TOC, alkalinity, chloride, sulfate, ethane, ethene, dissolved iron, manganese, nitrate, and VFA concentrations remained near baseline concentrations during the pilot study. Methane concentrations increased from a baseline of 0.076 mg/L to 1.4 mg/L in December. Field parameters, including DO, ORP, specific conductance, and pH generally remained consistent with baseline concentrations.

In summary, there is evidence that reductive dechlorination at MW-522S is occurring, but little evidence to suggest it has been enhanced by the EOS™ solution.

3.4.7 Results for MW-505D

MW-505D is located approximately in the middle of Area 5 approximately 7 feet northwest (upgradient) of a deep injection well line. Baseline concentrations of TCE (17 mg/L), cis-1,2-

DCE (41 mg/L), and vinyl chloride (1.9 mg/L) increased to 30 mg/L, 54 mg/L, and 3.2 mg/L, respectively, during the pilot test. The increase in TCE may be a result of displacement of the plume with a more concentrated portion of the plume displaced to this monitoring well. Increases in cis-1,2-DCE and vinyl chloride are likely related to both displacement and reductive dechlorination of TCE.

Natural attenuation parameter results indicative of reducing conditions at MW-505D are inconsistent. Parameter results at MW-505D indicative of natural attenuation include nitrate concentrations less than 1 mg/L, elevated concentrations of ethene, and elevated concentrations of dissolved iron. However, high sulfate concentrations, in addition to low concentrations of methane and manganese, indicate conditions are not strongly reducing and were not enhanced by injection of EOS™. TOC concentrations were little changed throughout the test indicating the EOS™ did not reach MW-505D during the pilot test. Field parameters indicate ORP measurements are negative suggesting that reducing conditions are present.

In summary, there is evidence that reductive dechlorination at MW-505D is occurring, but little evidence to suggest that it has been enhanced by the EOS™ solution. Enhancement is likely occurring upgradient of MW-505D, but the treated groundwater has not yet migrated to MW-505D.

3.4.8 Results for MW-520D

MW-520D is located approximately 20 feet southeast (downgradient) of the southeastern most injection well line. Performance monitoring data collected from MW-520D provides strong evidence of EISB. The baseline TCE concentration of 44 mg/L declined following injection of EOS™ to 29 mg/L in June and 5.1 mg/L in December. Baseline concentrations of cis-1,2-DCE (84 mg/L) decreased to 57 mg/L in June before increasing to 130 mg/L in December. Similar to cis-1,2-DCE, baseline concentrations of vinyl chloride (3.7 mg/L) increased to 33 mg/L in December. Increases in concentrations of daughter products, cis-1,2-DCE and vinyl chloride, indicate reductive dechlorination of TCE is taking place as confirmed by the decreasing concentrations of TCE.

Natural attenuation parameters indicate reducing conditions were present at MW-520D, baseline reducing conditions have been enhanced by the injection of EOS™, and reductive dechlorination is ongoing. TOC concentrations remained near baseline (0.83 mg/L) until December when TOC concentrations increased to 98 mg/L. Alkalinity values also increased in December to 540 mg/L from a baseline concentration of 370 mg/L. Sulfate concentrations decreased from the baseline concentration of 120 mg/L to 55 mg/L in December. Chloride concentrations gradually increased during the pilot test from a baseline concentration of 250 mg/L to 320 mg/L in December. No VFAs were detected in MW-520D during baseline sampling. In December sampling, butanoic (12 mg/L), acetic (180 mg/L), and propionic (46 mg/L) were detected indicating enhanced biological activity. Substantial increases, over baseline, in dissolved iron and ethene concentrations were measured during the pilot test. Dissolved iron concentrations increased to 26 mg/L in December from a baseline concentration of 6.67 mg/L. Baseline ethene concentrations (0.069 mg/L) increased to 1.6 mg/L in December, the highest concentrations measured in Area 5 during the pilot test.

Field parameter measurements support the enhancement of baseline reducing conditions during the pilot test. Specific conductance measurements remained near baseline conditions of 1,614 µs/cm until December when the specific conductance rose to 2,180 µs/cm. ORP decreased during the pilot test from a baseline of -57 mV to -138 mV in December.

3.4.9 Results for MW-521D

MW-521D is located approximately 25 feet southeast (downgradient) of the most downgradient deep injection well line. Performance monitoring data collected from MW-521D provides strong evidence of EISB. Baseline TCE concentration (1.1 mg/L) decreased to less than 0.001 mg/L in December after an increase to 1.5 mg/L in June. Baseline cis-1,2-DCE concentrations (8.5 mg/L) decreased to 6.3 mg/L in September before increasing substantially to 13 mg/L in December. Similar to cis-1,2-DCE, baseline vinyl chloride concentration (3.1 mg/L) decreased to 1.8 mg/L in September before increasing to 6.1 mg/L in December.

Results of natural attenuation parameter monitoring are indicative of reducing conditions. In general, chloride, alkalinity, manganese, and nitrate remained consistent with baseline conditions. Baseline TOC concentration (0.7 mg/L) generally remained consistent with baseline concentrations expected for a detection of 20 mg/L in November. Sulfate concentration decreased during the pilot test from 78 mg/L to 32 mg/L in December. Dissolved iron concentrations increased from a baseline of 4.6 mg/L to 8.5 mg/L in December. VFAs were not detected during baseline sampling; however, 3 mg/L of acetic acid was detected in December sampling. Baseline ethane concentration of 0.0027 mg/L significantly increased in June 2007 to 3.2 mg/L, but returned to near baseline for the duration of the pilot test.

Field parameter measurements indicate reducing conditions. DO concentrations have generally remained below 1 mg/L. ORP values decreased from a baseline of -90 mV to -126 mV in December with a low of -173 mV in September.

3.4.10 Results for MW-522D

MW-522D is located approximately 5 feet southeast (downgradient) of a deep injection well line near the mid-point of Area 5. Baseline TCE concentrations (23 mg/L) increased to 110 mg/L in June and then decreased to 100 mg/L in September and 10 mg/L in December. Cis-1,2-DCE concentrations increased from a baseline concentration of 9.3 mg/L to 31 mg/L in December. Vinyl chloride concentrations also increased from a baseline of 0.9 mg/L to 1.5 mg/L in December.

Natural attenuation parameters and field parameters show no significant change from baseline conditions during the pilot test with the exception of ethene. Ethene concentrations declined from a baseline of 0.092 mg/L to 0.009 mg/L in December.

In summary, there is evidence that reductive dechlorination at MW-505D is occurring, but limited evidence to suggest that it has been enhanced by the EOS™ solution. The fluctuations in TCE concentrations are likely related to displacement of higher concentration groundwater during injection activities.

SECTION 4

Conclusions and Recommendations

Where the injected amendments reached the monitoring wells, they were effective at enhancing naturally occurring reducing conditions to reduce TCE concentrations. Performance monitoring data clearly shows the arrival of substrate at Area 4 monitoring wells MW-527D, MW-514D, and MW-529D, and Area 5 monitoring wells MW-520D and MW-521D. A summary of TCE reductions is presented in Table 4-1.

TABLE 4-1
Summary of TCE Reductions

Monitoring Well ID	Treatment Area	Baseline TCE Concentration (mg/L)	December TCE Concentration (mg/L)	Percent Reduction (%)
MW-527D	4	0.63	<0.001	>99
MW-514D	4	0.5	<0.001	>99
MW-529D	4	0.099	<0.001	>99
MW-520D	5	44.0	5.1	88
MW-521D	5	1.1	<0.001	>99

Reductions in TCE concentrations greater than 99 percent were measured in Area 5 and Area 4; however, the baseline TCE concentrations were at least 1 order of magnitude lower in Area 4 than Area 5. Where elevated TOC concentrations have been measured in Area 5, the concentration has not been increased as substantially as in Area 4. This difference may be related to the multiple injections in Area 4 providing better distribution or the slower dissolution of EOS™ resulting in the slower release of TOC to the aquifer. The 10-month duration of the pilot study may not have been sufficient to accurately characterize any enhancements that the slower dissolution of EOS™ may have on Area 5. The ability of the sodium lactate to achieve higher TOC concentrations in a shorter period of time indicates that it may be able to enhance naturally occurring reductive conditions in a shorter period of time; however, the frequent re-injections required may increase the per unit treatment cost of sodium lactate. A complete cost comparison of the two amendments will be prepared in the revised groundwater feasibility study.

It is evident based on TOC concentrations and natural attenuation parameters that the injected amendments have yet to reach several monitoring well locations in both treatment areas. This has occurred at MW-522D, MW-522S, MW-519S, MW-519D, MW-505D, MW-514S, and MW-528D. It is expected that EISB has occurred upgradient of these locations, but the effect has yet to be seen because of the longer travel time from the injection area to the monitoring location.

Four objectives related to EISB were developed prior to implementation to evaluate the results of the EISB pilot test.

1. Evaluate the degree to which in-situ treatment can reduce the concentrations of TCE and daughter products (cis-1,2-DCE and vinyl chloride) in the target treatment zones and downgradient monitoring locations.

Reductions in TCE, cis-1,2-DCE, and vinyl chloride concentrations are evident in Areas 4 and 5 as a direct result of EISB resulting from injection of sodium lactate and EOS™. However, a direct comparison of effectiveness between EOS™ and sodium lactate as EISB amendments is not possible. The cap provided by the existing building appears to enhance the reducing conditions beneath the building. In addition, the concentrations of VOCs in Area 5 are significantly higher than VOC concentrations in Area 4. Sodium lactate appears to have greater effectiveness in the deeper portions of the aquifer than the shallow areas likely due to the infiltration of fresh water in the absence of a surface cap in Area 4 which inhibits the development of strongly reducing, methanogenic conditions within the duration of the pilot test. However, indications are that these conditions can be achieved in the shallow portions of Area 4 over time.

2. Determine the overall effectiveness of in situ treatment for achieving complete reduction of TCE to non-toxic degradation products (such as ethane or ethene).

Strong evidence exists showing the reduction of TCE, cis-1,2-DCE, and vinyl chloride. Complete dechlorination of TCE to non-toxic end products is clearly evident at Area 4 in MW-527D and at Area 5 in MW-520S. A detailed evaluation of the complete reduction is complicated by the few data points available for analysis. Concentration of cis-1,2-DCE and vinyl chloride generally decreased after TCE had been reduced to below detection limits, effectively cutting off the parent product source.

3. Monitor the duration that the injected substrates can maintain enhanced, relative to background, reducing conditions for in situ treatment.

Sampling results indicate that in monitoring wells influenced by the EISB injections, reducing conditions have been generated or enhanced throughout the approximate one-year duration of the pilot test. The EOS™ substrate has persisted for 10 months with one injection while sodium lactate has persisted following a quarterly re-injection program. The ultimate longevity of the EOS™ amendment cannot be determined based on the short duration of the pilot study; however, the effective duration of EOS™ is estimated at 2 to 3 years. Based primarily on TOC data, the persistence of sodium lactate is between 3 and 6 months.

4. Determine the radius of influence of the selected injection method.

The selected injection method was highly effective at delivering the amendments into the aquifer. The radius of influence was estimated prior to pilot test implementation using geotechnical data collected during RI activities. Pilot test data indicate that some heterogeneity may be present across the site resulting in an increased or decreased radius of influence from the original estimates. In general, the radius of influence estimated during pilot test planning, 11 feet, was able to be achieved by the injection method. In addition, strong evidence exists of a downgradient migration of the amendments from the injection locations to monitoring wells despite a relatively low groundwater velocity.

SECTION 5

References

CH2M HILL. 2006. *OMC Plant 2 (OU#4) Groundwater Treatment Pilot Study.*

CH2M HILL. 2006a. *Feasibility Study Report.*

CH2M HILL. 2006b. *Remedial Investigation Report.*

CH2M HILL. 2006c. *Supplemental Field Sampling Plan.*

CH2M HILL. 2007. *Supplemental Quality Assurance Project Plan.*

CH2M HILL. 2008. *Data Evaluation Summary Report.*

Figures

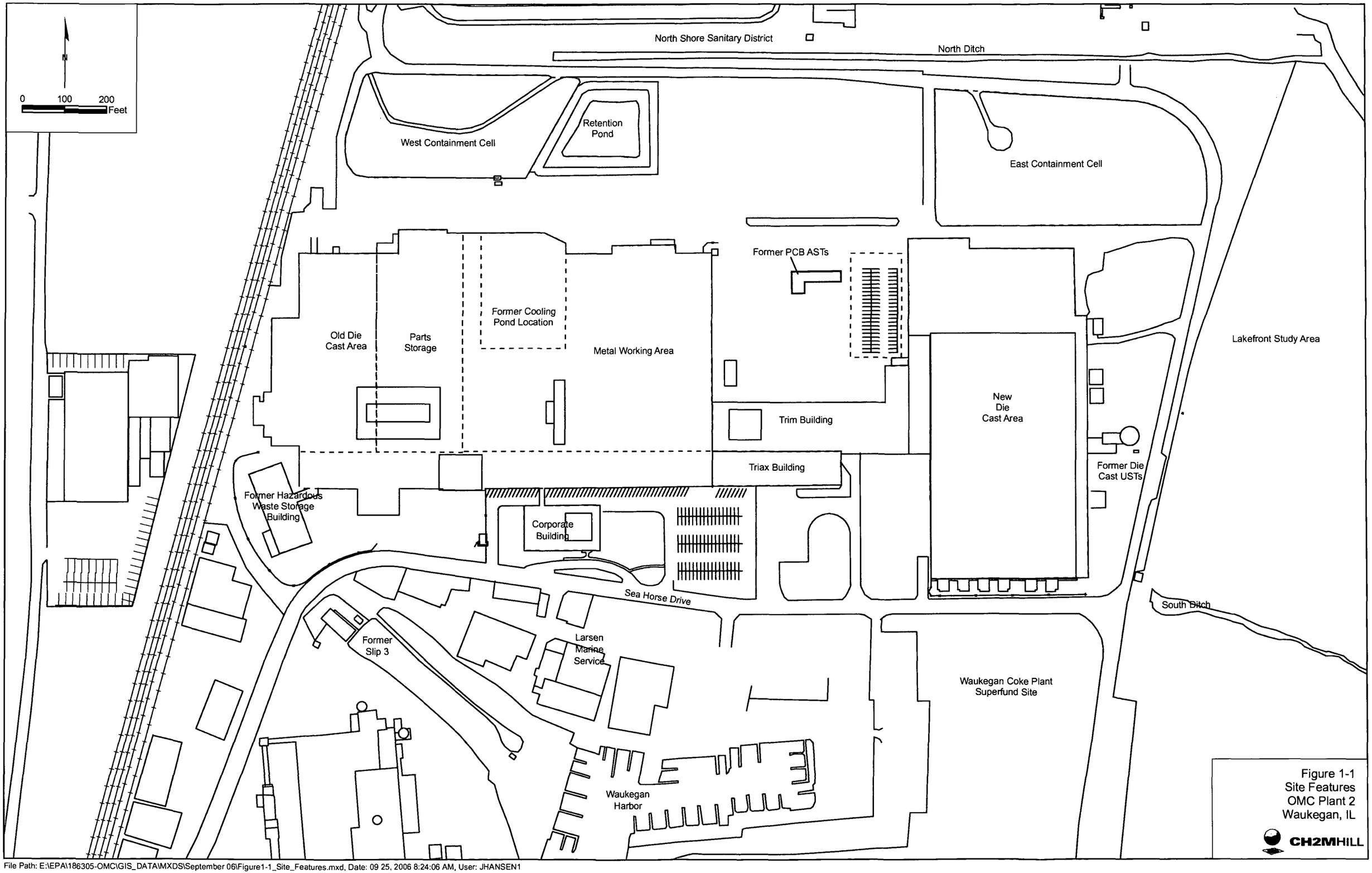

Figure 1-1
Site Features
OMC Plant 2
Waukegan, IL

CH2MHILL

File Path: E:\EPA\186305-OMC\GIS_DATA\MXDS\September 06\Figure1-1_Site_Features.mxd, Date: 09 25, 2006 8:24:06 AM, User: JHANSEN1

N

0 100 200
Feet

Area 1

Area 2

Area 3

Area 4

Area 5

PARTS STORAGE

OLD DIE CAST AREA

FORMER COOLING POND LOCATION

METAL WORKING AREA

TRIM BUILDING

NEW DIE CAST AREA

TRIAX BUILDING

FORMER HAZARDOUS WASTE STORAGE BUILDING

CORPORATE BUILDING

FORMER SLIP 3

LARSEN MARINE SERVICE

WAUKEGAN HARBOR

WAUKEGAN COKE PLANT SUPERFUND SITE

SOUTH DITCH

Figure 1-2
Site Features & Source Areas
OMC Plant 2
Waukegan, IL

CH2MHILL

MKE \\WAVE\PROJ\EPA\186305-OMC\GIS_DATA\MXDS\022608\FIGURE01-02_SITE_FEATURES_SOURCE_AREAS.MXD 2/26/2008 16:49:36

N

0 100 200
Feet

MW-5
W-11
W-12
MW-500D
MW-500S
W-7
MW-501D
MW-501S
W-8
W-9
W-10
MW-502D
MW-502S
MW-503D
MW-503S
MW-518S
MW-518D
W-6
W-5
W-12E
MW-519D
MW-519S
MW-505D
MW-505S
MW-520S
MW-520D
MW-506D
MW-506S
MW-504D
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MW-524S
MW-526S
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MW-514S
MW-527S
MW-527D
MW-515D
MW-515S
MW-102
W-3
MW-11S
MW-11D
MW-3S
MW-3D
MW-14D
MW-14S
W-2
W-4
MW-516S
MW-516D
MW-7D
MW-7S
W-1

Legend

- New Monitoring Well
- Existing Monitoring Well
- OMC Plant 2 Building Outline

Figure 2-1
New and Existing Monitoring Well Locations
OMC Plant 2

CH2MHILL

MKE \\WAVE\PROJ\EPA\186305-OMC\GIS_DATA\MXDS\022608\FIGURE02-01_NEW AND EXISTING MWS.MXD 2/26/2008 17:08:51

N

0 15 30 Feet

Groundwater Flow Direction

Area 4

32'

IW-400 IW-401 IW-402 IW-403 IW-404 Shallow

IW-405 IW-406 IW-407 IW-408 IW-409 Deep

28'

MIP-053

SO-055

MW-529S

MW-529D

MIP-054

IW-410 IW-411 IW-412 IW-413 IW-414 Deep

28'

IW-415 IW-416 IW-417 IW-418 IW-419 Deep

MW-528S

MIP-058

MW-528D

MW-527D

MW-527S

MIP-059

MW-514D

MW-514S

MIP-069

MIP-070

MIP-068

MIP-056

MIP-060

MIP-061

LEGEND

- Membrane Interface Probe
- Newly Installed Monitoring Wells
- Newly Installed Injection Wells
- Injection Barriers
- Source Zones

Figure 2-2
Source Zones Area 4
OMC Plant 2

CH2MHILL

MKE \\WAVE\PROJ\EPA\186305-OMC\GIS_DATA\MXDS\022608\FIGURE02-02_SOURCE_ZONES_AREA4.MXD 2/27/2008 08.31.56

0 100 200 Feet

MW-500S 582.28

MW-502S 583.01

MW-518S 582.74

MW-503S* NA

MW-519S 583.13

MW-505S 583.02

MW-504S 582.71

MW-520S 582.86

MW-506S 582.80

MW-523S 582.64

MW-522S 583.00

MW-524S 582.70

MW-526S 582.71

MW-509S 583.47

MW-521S 582.907

MW-525S 582.70

MW-507S 582.63

MW-510S 582.70

MW-511S 582.54

MW-517S 582.98

MW-512S 581.96

MW-529S 582.04

MW-530S 582.65

MW-513S 582.21

MW-528S 581.10

MW-514S 581.95

MW-527S 581.91

MW-11S 581.77

MW-516S 580.40

MW-15S 582.70

MW-3S 582.65

MW-14S 582.21

W-12E 582.25

W-13 582.38

MW-508S 582.53

583.40

583.20

583.00

582.80

582.60

582.40

582.20

582.00

581.80

581.60

581.40

581.20

581.00

580.80

580.60

Legend

- LNAPL In Well
- Existing Monitoring Well
- Groundwater Elevation
- OMC Plant 2 Building Outline

Figure 2-3
Shallow Groundwater Elevations - September 2007
Well Locations
OMC Plant 2

CH2MHILL

MKE \\WAVE\PROJ\EPA\186305-OMC\GIS_DATA\MXDS\022608\FIGURE02-03 - SHALLOWAQUIFERSEPT07.MXD 2/27/2008 08:36:00

N

0 100 200 Feet

W-11 583.55
W-12 582.35
W-7 582.05
MW-501D 581.45
MW-500D 582.32
W-8 581.40
W-9 582.83
W-10 583.39
MW-502D 583.00
MW-503D 582.87
MW-518D 582.75
MW-519D 583.11
MW-504D 582.70
MW-505D 583.02
MW-520D 582.86
MW-523D 582.74
MW-522D 582.99
MW-506D 582.79
MW-526D 582.70
MW-509D 583.44
MW-521D 582.90
MW-525D 582.68
MW-507D 582.67
MW-508D 582.46
MW-510D 582.64
MW-511D 582.55
MW-517D* 583.44
MW-512D 582.36
MW-15D 582.71
MW-513D 582.22
MW-528D 581.97
MW-529D 582.03
MW-514D 581.96
MW-515D 582.57
MW-527D 581.87
W-3 582.19
MW-11D 581.84
MW-3D 582.68
MW-14D 582.29
W-4 580.84
MW-516D 580.37
W-6 582.35
W-5 582.05

582.8
583
582.8
582.4
582
582.2
581.8
581.6
582.4
582
581.8
581.6
581.4
581.2
581
580.8
580.6
582.6
582.2

Legend

- * LNAPL In Well
- Existing Monitoring Well
- Actual Groundwater Elevation
- Estimated Groundwater Elevation
- OMC Plant 2 Building Outline

Figure 2-4
Deep Groundwater Elevations - September 2007
Well Locations
OMC Plant 2

CH2MHILL

MKE \\WAVE\PROJ\EPA\186305-OMC\GIS_DATA\MXDS\022608\FIGURE 02-04 - DEEPAQUIFERSEPT07.MXD 2/27/2008 08:40:45

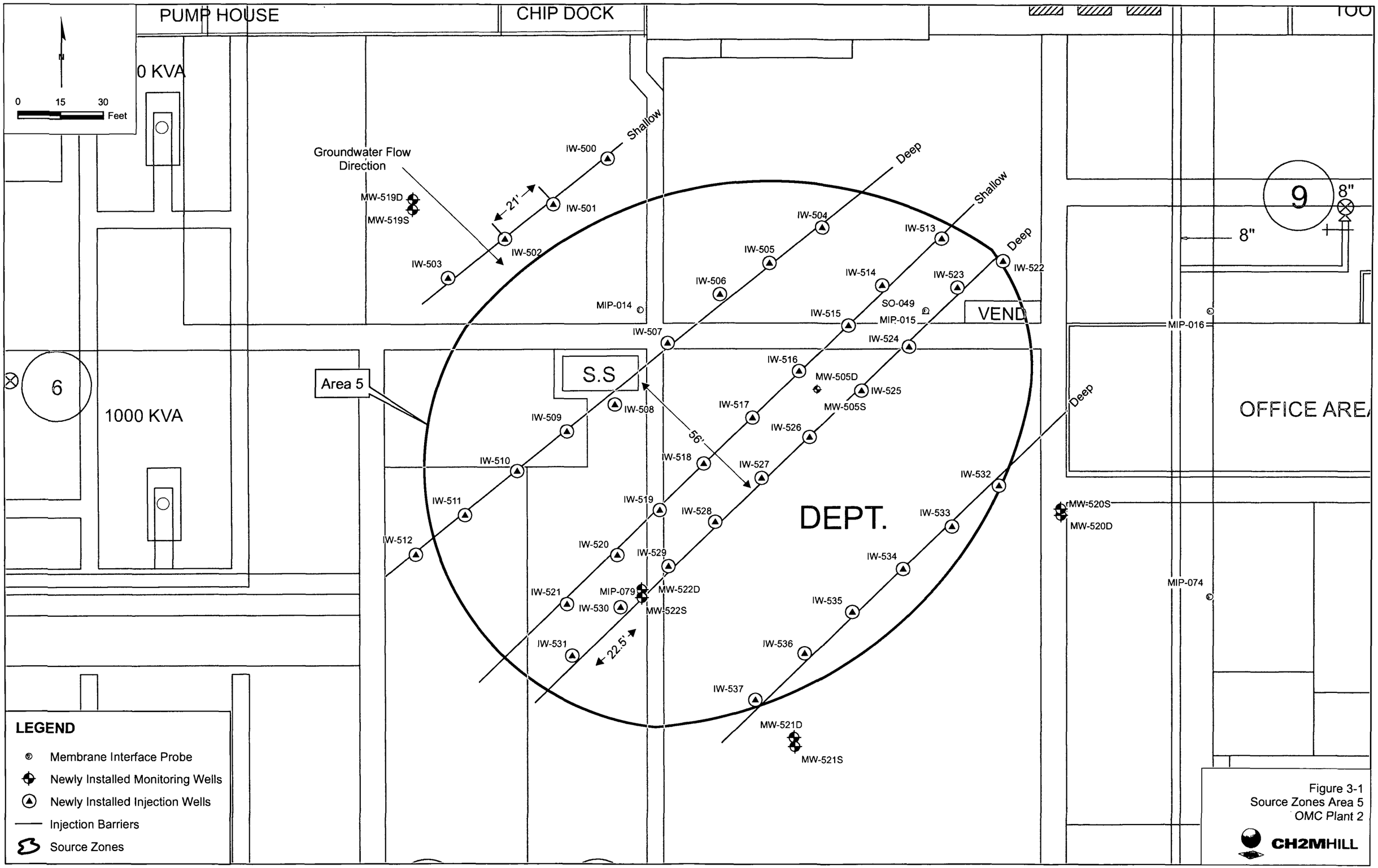

Figure 3-1
Source Zones Area 5
OMC Plant 2

CH2MHILL

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Appendix A

Technical Memo – Pilot Test Implementation

Pilot Test Implementation OMC Plant 2 (Operable Unit 4), Waukegan, Illinois — WA No. 018-RICO-0528CO-0528, Contract No. EP-S5-06-01

PREPARED FOR:	USEPA
PREPARED BY:	CH2M HILL
DATE:	February 20, 2008

Introduction

This memorandum documents the activities associated with the implementation of an enhanced in situ biodegradation (EISB) pilot test conducted as part of the remedial investigation (RI)/feasibility study (FS) at the Outboard Marine Corporation (OMC) Plant 2 site in Waukegan, Illinois. The pilot test has been designed to collect the data needed to evaluate whether EISB technologies would effectively treat the groundwater source zones of chlorinated volatile organic compounds (CVOCs). An additional objective of the pilot test is to examine the effectiveness of two different amendments—a soluble substrate (such as sodium lactate) and an edible oil substrate (EOS™).

The pilot test consisted of injecting the two selected substrates, sodium lactate, and EOS™ into shallow and deep zone injection wells in two separate sources areas. The initial injection of sodium lactate was conducted on March 12, 2007. The short longevity of sodium lactate, relative to EOS™, requires sodium lactate be injected quarterly. The schedule of the pilot study permitted four additional injection events on June 13, 2007, September 17, 2007, and January 8, 2008. EOS™ was injected into the source area on March 23, 2007. The extended period of dissolution allowed the pilot test to be completed using only one injection of EOS™.

The effectiveness of the amendment injection was evaluated through monthly groundwater quality monitoring. The post-injection monitoring included collecting and analyzing groundwater samples from shallow and deep zone monitoring wells within and adjacent to the treatment areas.

This memorandum includes the following:

- Description of the injection system, including the injection well array and equipment.
- Summary of the injection activities, including the concentration and amounts of solution injected and field activities performed.
- Description of performance monitoring activities including the timetable of sampling and injection events and parameters measured during groundwater sampling.
- References cited in this technical memorandum.

Injection System

Injection Wells

Prior to injection activities, a total of 58 permanent injection wells were installed in two source zone areas identified on Figure 1 as Areas 4 and 5. The permanent injection wells were installed in a barrier configuration and perpendicular to groundwater flow in each area to use natural advective transport as the mechanism to bring dissolved contaminants into contact with the amendments and be reductively dechlorinated. The spacing between lines of injection wells was based on an estimated travel time of 2 years for the shallow wells and 3 years for the deep wells. Because of the slower groundwater velocity and higher concentrations of contaminants observed in the deep zone, more injection wells were installed in the deep zone compared to the shallow zone.

The injection well array in Area 4, as shown on Figure 2, consists of four parallel rows of wells (three rows of deep injection wells and one row of shallow injection wells). The rows are oriented west to east, perpendicular to the north to south groundwater flow direction. The three rows of deep wells are spaced approximately 30 feet apart. Each shallow well is placed approximately 30 feet apart from the adjacent shallow well and each deep well is spaced approximately 25 feet apart, along the west to east axis.

The injection well array in Area 5 consists of five parallel rows of wells (three rows of deep injection wells and two rows of shallow injection wells), as shown on Figure 3. The rows are oriented southwest to northeast, perpendicular to the northwest to southeast groundwater flow direction. The three rows of deep injection wells are spaced approximately 56 feet apart. Only one row of shallow wells was used for the pilot injection of EOS™, and it is located in the approximate center of Area 5. In Area 5, both shallow and deep wells are placed approximately 22.5 feet apart from each other along the southwest to northeast axis.

All shallow injection wells are approximately 15 feet in depth and screened in overlying unconsolidated material between approximately 9.5 to 14.5 feet below ground surface (bgs). The deep injection wells were screened in overlying unconsolidated material above the till at depths ranging from 21 to 26 feet and 22 to 27 feet bgs. All injection wells were constructed with 2-inch inside diameter (ID), schedule 40, polyvinyl chloride (PVC) casing and 5-foot stainless-steel, continuous wire-wrapped screens with 0.010-inch slots and fitted with flush-mount casings. Locks were installed on all injection wells.

Injection Equipment

A mobile injection system was constructed by the subcontractor, Innovative Probing Solutions (IPS), and used to inject both substrates. The injection system consisted of a positive displacement pump and manifold system constructed on a trailer. The pump was sized to deliver 10 gallons per minute (gpm) per well for up to eight injection wells at one time. Flow rates and the total volume of substrate solution injected for each well was measured by individual flow meters attached at the outlet of each of the eight injection ports. Flow to each well was adjusted using individual ball valves, connected to each of the eight flow meters by a 1-inch PVC pipe. Figure 4 shows the injection system process flow diagram and presents the layout of the injection manifold system, location of the flow meters, and flow adjustment ball valves to each injection port. Pictures of the injection system are provided in Appendix A.

Two injection pumps were used to transfer the amendment solution from a 1,000-gallon polyethylene mixing tank into the injection manifold. When injecting at a flow rate of 10 gpm, only one pump was required, however, the additional pump offered the energy required for faster injection flow rates. The head in the system based on the volume of liquid in both the frac tank and the mixing tank was also a factor in how many pumps were required. A pressure gauge was attached to the pump discharge pipe to monitor the injection system pressure. During injection, total system pressure was not to exceed 20 pounds per square inch (psi) without causing damage or equipment failure, and a pressure of 15 psi or less was ideal. If the pressure in the system began to approach 20 psi, the bypass valve was opened to allow some of the injection solution to re-circulate back into the mixing tank while still allowing continued injection into the wells through the manifold.

At each injection well, a water-tight connection was required. A total of eight wellhead connections were constructed by IPS. These connections were constructed to be capable of handling a maximum of 30 psi; however, during the injections, pressures at each wellhead never exceeded 11 psi. Each wellhead connection was constructed of threaded 2-inch PVC and consisted of a pressure gauge, a substrate solution influent port with a quick connect lock, and an air release valve to relieve any excess air that might enter the well through the injection system. Each wellhead connection was screwed onto the threaded PVC well casing to form a watertight seal. Figure 5 presents the wellhead configuration.

The substrate solution was pumped from the injection trailer into each of the injection wells through a 1.5-inch Kanaflex hose. The shortest length of hose was used between the trailer and each injection point to minimize head loss and air entrainment. Up to eight wells could be injected at one time; each injection port on the manifold not being used was closed with a ball valve.

For the first three sodium lactate injections, the freshwater to mix with the amendment prior to injection was supplied by a fire hydrant located adjacent to Area 4. Two 18,100-gallon frac tanks were mobilized to the site and placed on the concrete pad of the former corporate building, just west of Area 4. Figure 6 shows the general layout of the injection system water supply locations. These tanks were inspected for debris and then filled with water supplied by the hydrant using approximately 300 feet of 2.5-inch fire hose. The Waukegan Department of Public Works activated the hydrant and provided training regarding hydrant operation. The fourth injection took place in January and the hydrant was not available as a fresh water source for the injection due to the cold temperatures and the possibility of freezing the hydrant line. An offsite water source was located and 10,000 gallons was delivered to the site for the final injection. Due to the decreased amount of water available, the sodium lactate concentration of the injection solution was increased from 0.5 percent used in the previous injections to 3 percent. Details regarding the solution concentration are addressed in the following section.

Injection Activities

Prior to the start of each injection, the depth to water (DTW) amount was measured at each of the injection and monitoring wells. This information was used evaluate whether water levels increased during injection (i.e., mounding), which would indicate that the subsurface was not absorbing the injected solution. Mounding was not observed during the injections.

Tables showing the DTW measurements collected throughout each of the injections are included in Appendix B.

Following the completion of the baseline DTW measurements in each area, the Kanaflex hose and wellhead attachments were connected to the first set of 8 injection wells that were to be injected with solution. A summary of the sequence for the areas of injection is included below as Table 1. During the fourth injection, a maximum of six wells were injected at one time due to faulty flow meters.

TABLE 1
Injection Sequence – Injections 1, 2, and 3

Area	Order	Injection Wells
Area 4	1	IW-400, IW-404, IW-406, IW-408, IW-410, IW-412, IW-414, IW-416
Area 4	2	IW-401, IW-403, IW-407, IW-411, IW-413, IW-415, IW-417, IW-419
Area 4	3	IW-402, IW-405, IW-409, IW-418
Area 5	4	IW-504, IW-506, IW-508, IW-510, IW-512, IW-527, IW-529, IW-531
Area 5	5	IW-513, IW-515, IW-517, IW-519, IW-521, IW-533, IW-535, IW-537
Area 5	6	IW-505, IW-507, IW-509, IW-511, IW-524, IW-526, IW-528, IW-530
Area 5	7	IW-514, IW-516, IW-518, IW-520, IW-522
Area 5	8	IW-523, IW-525, IW-532, IW-534, IW-536
Injection Sequence – Injection 4		
Area 4	1	IW-412, IW-416, IW-414, IW-406, IW-404
Area 4	2	IW- 403, IW-417, IW-413, IW-411, IW-410, IW-400
Area 4	3	IW-409, IW-418, IW-402, IW-400, IW-415, IW-405
Area 4	4	IW-419, IW-407, IW-401

Sodium lactate was injected into the 20 injection wells in Area 4 four times during the pilot test. Substrate was transferred from 55-gallon drums into 5-gallon buckets using a drum pump, and then manually added to the poly tank to create the substrate solution. Solution was injected to the wells using a 1,000-gallon poly tank that was continuously filled with water. Substrate was added directly to this poly tank as the injection was occurring, resulting in a continuous flow of solution into each of the wells. For the volume and concentration of the solution injections, refer to Table 2. A total of six 55-gallon drums were used for each injection of sodium lactate that occurred between March 2007 and January 2008.

A similar process was used to deliver the solution to the wells receiving EOS™ solution, except EOS™ was poured directly from the drum into the 1,000-gallon poly mixing tank. The flow of the EOS™ into the poly tank was controlled with a valve, and averaged about 2 gpm. The injection solution was continuously being made as water and solution were added to the poly tank while solution was being injected. At the end of injection in Area 5, a total of 26 drums (1,430 gallons) of EOS™ had been injected.

Table 2 shows a summary of the total gallons of substrate, water, and substrate/water solution injected per area, per event, and per well. It also provides a summary of the approximate volume of solution injected per shallow and deep wells in each area. Separate injection volumes and concentrations are provided for the fourth injection because of the concentrated solution used during that event. Once the appropriate volume of solution had been injected into a well, the individual ball valves for the well was closed to prevent further injection of any solution.

A conservative injection rate of 10 gpm had been set as a baseline for injecting the solution. This rate had been estimated based on subsurface hydrogeology, soil type, and expected injection pressures. During injection in the field, higher flow rates were achieved without exceeding the maximum pressure limits and without excessive mounding around the wells. Flow rates of up to 20 gpm were achieved during portions of the injection, especially when less than 8 wells were being injected simultaneously. During these higher flow rates, the maximum pressure recorded at the wellheads was 11 psi. Injection flow rate, injection volumes, injection times, and pressures were recorded throughout each injection event and the data collected during each injection is provided in Appendix C.

TABLE 2
Mixing Summary – Injections 1, 2, and 3

Area	Zone	Material	Ratio of Substrate to Water (%)	Total Injection Solution Per Event (gal)	Total Substrate Per Event (gal)	Total Water Per Event (gal)	Solution Injected Per Well Per Event (gal)	Substrate Injected Per Well Per Event (gal)	Water Injected Per Well Per Event (gal)
4	Shallow	Lactate	0.53	11,235	59	11,176	2,247	12	2,235
4	Deep	Lactate	0.53	46,815	247	46,568	3,121	16	3,105
5 (Injection 1 only)	Shallow	EOS™	1.9	11,376	212	11,164	1,264	24	1,240
5 (Injection 1 only)	Deep	EOS™	1.9	63,200	1188	62,012	2,528	48	2,480
Mixing Summary – Injection 4									
4	Shallow	Lactate	3.07	1,994	59	1,934	399	12	387
4	Deep	Lactate	3.06	8,308	247	8,061	554	16	537

Performance Monitoring

Groundwater samples were collected on a monthly basis throughout the pilot test and analyzed to determine if the injected substrate(s) enhanced the reducing conditions in the source area creating favorable conditions for reductive dechlorination. Groundwater samples were collected from a total of 18 groundwater monitoring wells. The injection and monitoring well locations for Areas 4 and 5 are shown on Figures 5 and 6.

Prior to injection, an initial groundwater sampling event was performed to establish baseline groundwater quality conditions. Post-injection monitoring started 30 days after the completion of the first injection and consisted of primary and secondary events. The schedule for injection and sampling events is shown in Table 3.

TABLE 3
Injection and Groundwater Sampling Schedule

Sampling Event		Number of Days Post Injection	Dates
Injection			
	Sodium Lactate	0	03/14/07 – 03/16/07
	EOS	0	03/22/07 – 03/27/07
	Secondary Monitoring	30	04/12/07 – 04/13/07
	Secondary Monitoring	60	05/14/07 – 05/15/07
	Primary Monitoring*	90	06/11/07 – 06/13/07
Injection			
	Sodium Lactate	0	06/13/07 – 06/15/07
	Secondary Monitoring	30	07/12/07 – 07/13/07
	Secondary Monitoring	60	08/13/07 – 08/14/07
	Primary Monitoring*	90	09/13/07 – 09/14/07
Injection			
	Sodium Lactate	0	09/17/07 – 09/19/07
	Secondary Monitoring	30	10/15/07 – 10/16/07
	Secondary Monitoring	60	11/14/07 – 11/15/07
	Primary Monitoring*	90	12/10/07 – 12/13/07
Injection			
	Sodium Lactate	0	01/08/08
	Secondary Monitoring	30	01/21/08 and 01/23/08

The parameters analyzed during the primary and secondary groundwater sampling events are shown in Table 4 below.

TABLE 4
List of Enhanced In Situ Bioremediation Monitoring Parameters

Primary Sampling Parameters	Secondary Sampling Parameters
Water Level	Water Level
Turbidity	Turbidity
Temperature	Temperature
Specific Conductance	Specific Conductance
Oxygen Reduction Potential (ORP)	ORP
Dissolved Oxygen (DO)	DO
pH	pH
Alkalinity	Total Organic Carbon (TOC)
Nitrate/Nitrite	
Volatile Organic Compounds	
Chloride	
Ferrous Iron	
Dissolved Manganese	
Sulfate	
Sulfide	
Methane/Ethane/Ethene	
Volatile Fatty Acids (VFAs)	
TOC	

Samples were collected using low-flow purging and sampling methods as described in the *Supplemental Field Sampling Plan* (CH2M HILL, 2006) and in accordance with procedures outlined in the *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers* (USEPA, 2002). Analytical results from the groundwater sampling events can be found in *Enhanced In-Situ Bioremediation Pilot Test Report* (CH2M HILL, 2008).

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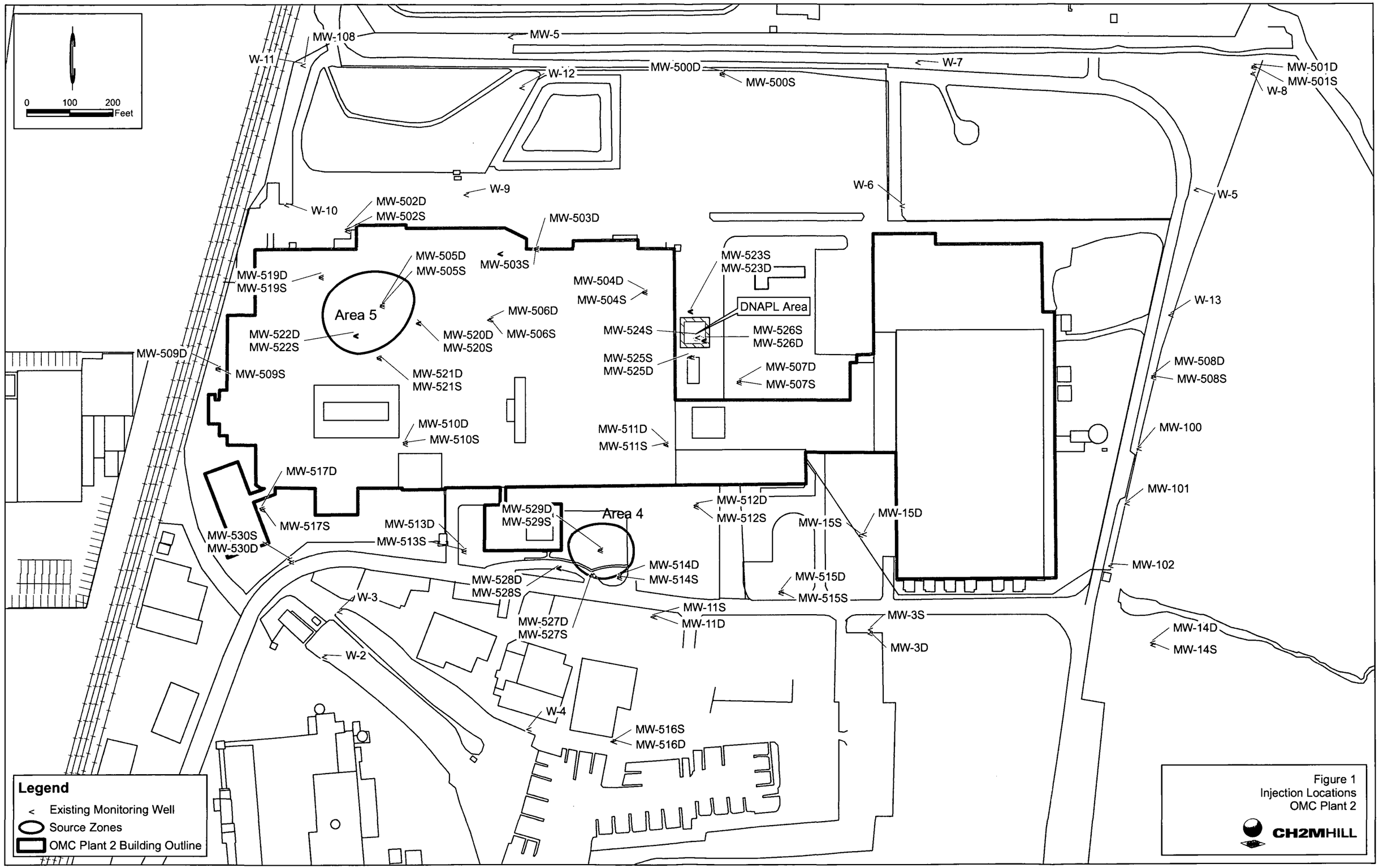
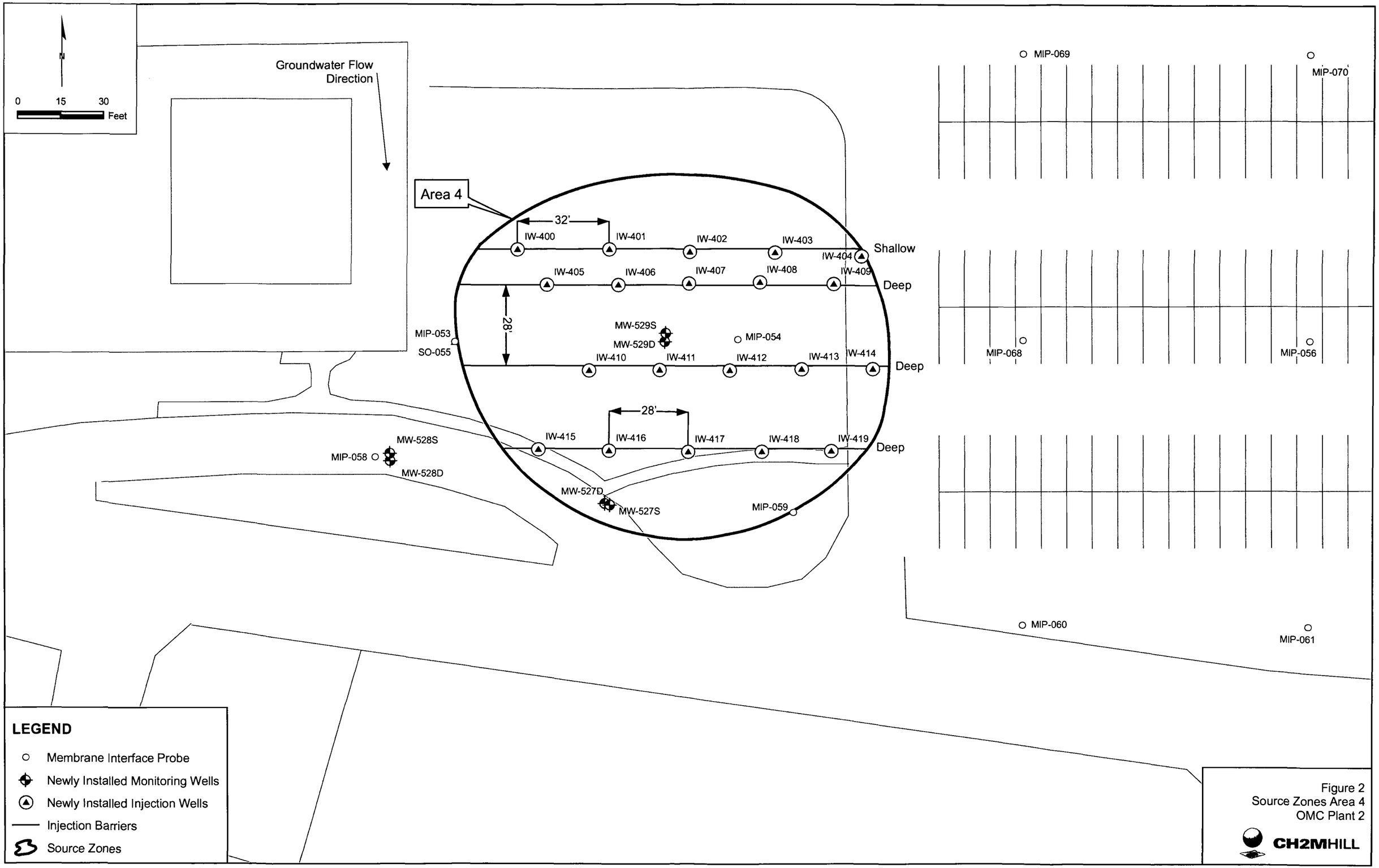
Figures



MKE \\WAVE\PROJ\EPA\186305-OMC\GIS_DATA\MXDS\012907\FIGURE 01 - INJECTION LOCATIONS.MXD 1/22/2008 15:54:55



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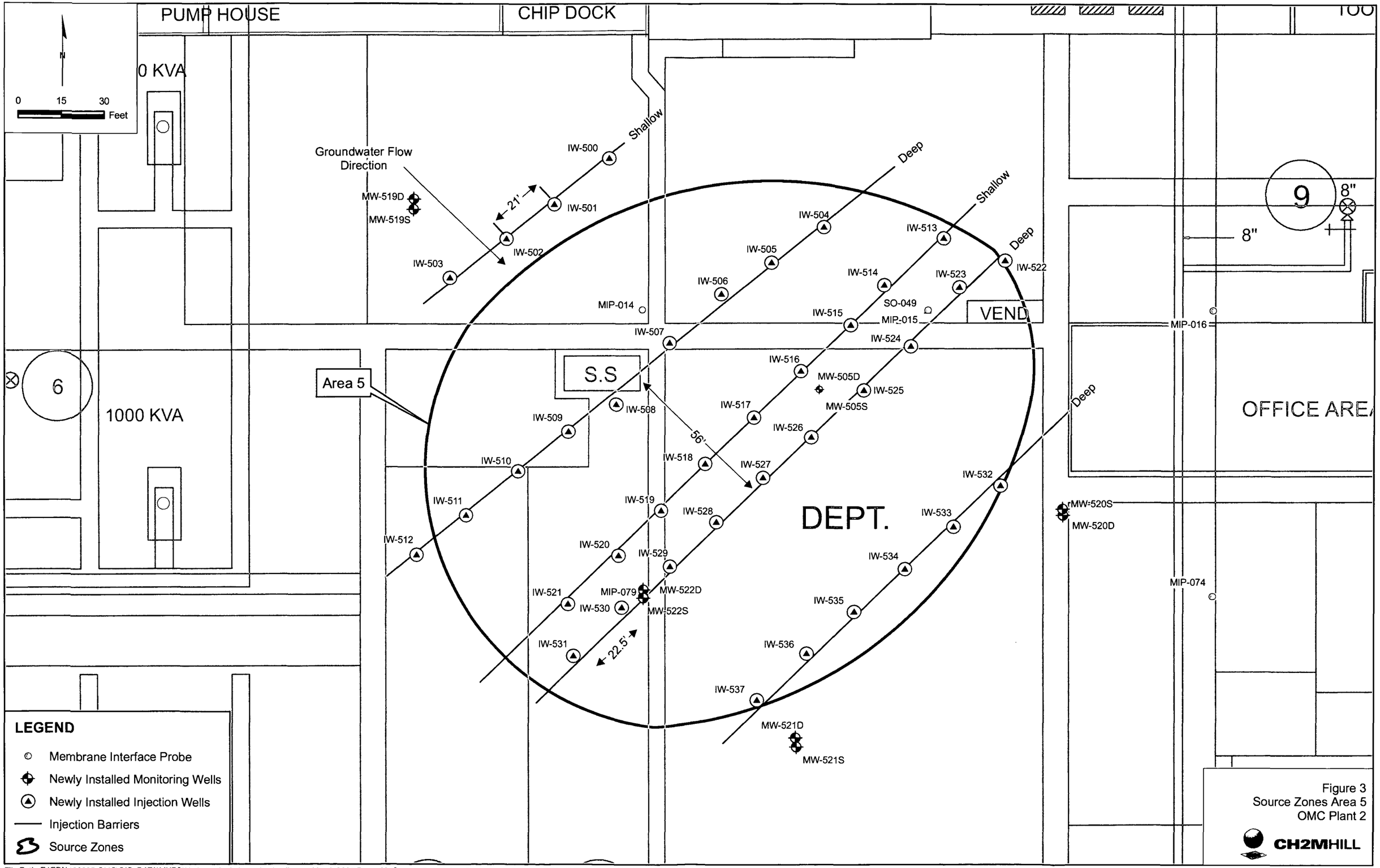

Figure 3
Source Zones Area 5
OMC Plant 2

CH2MHILL

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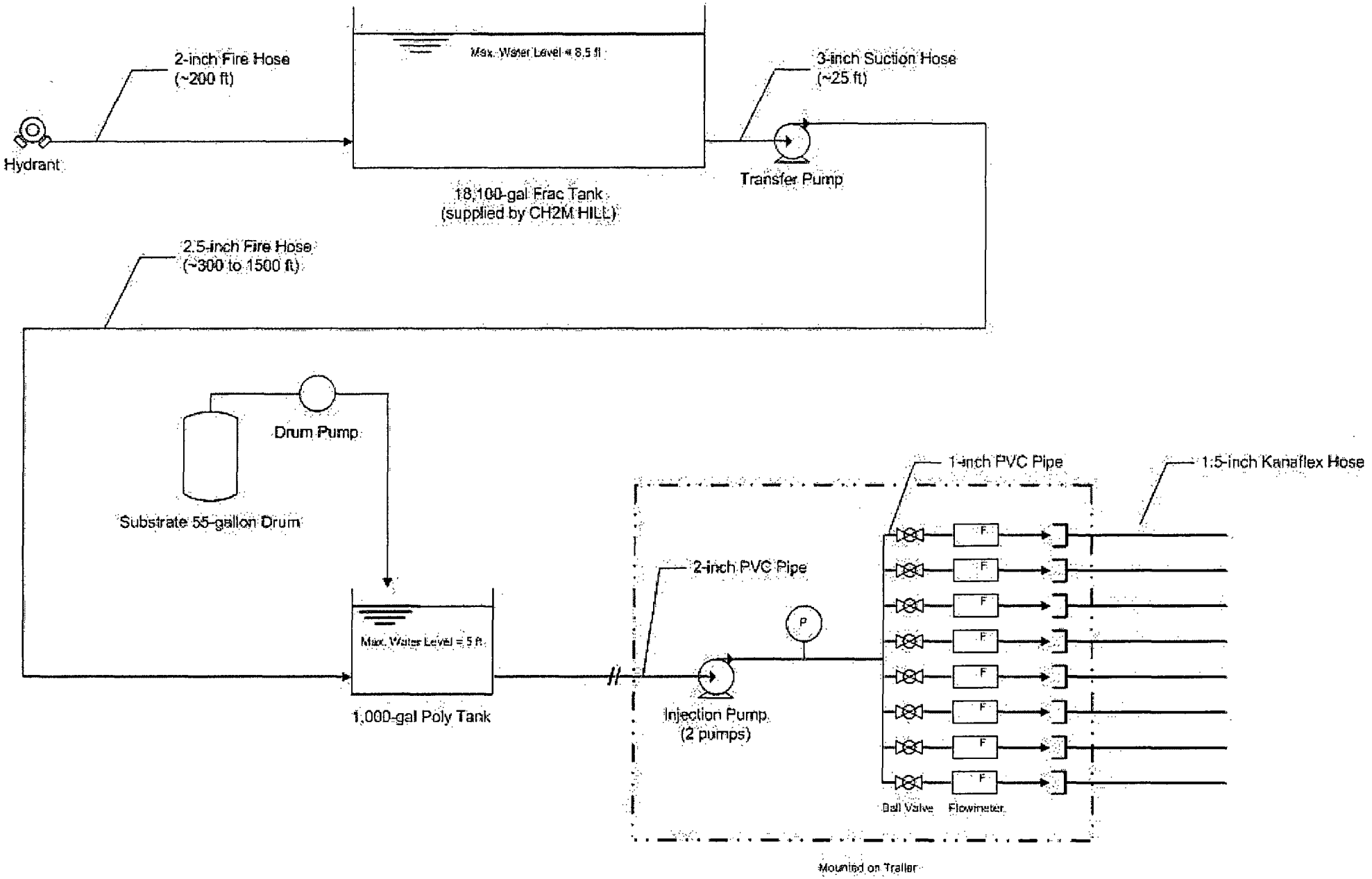
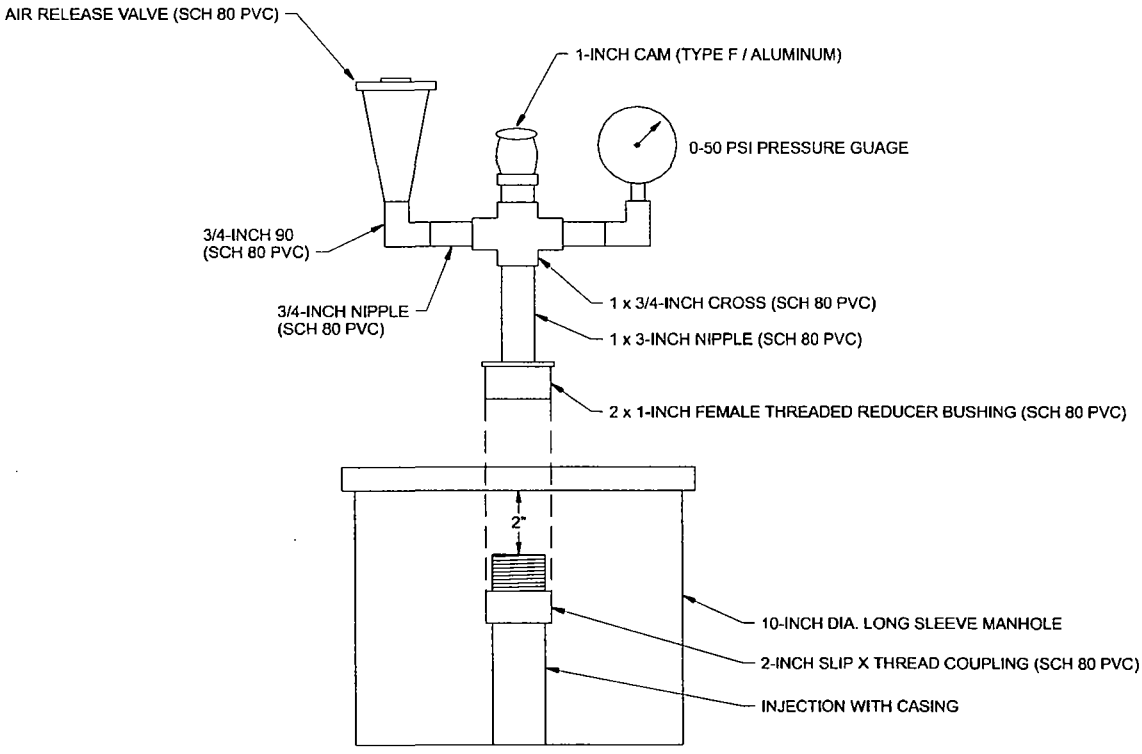


FIGURE 4
Injection System Process Flow Diagram
OMC Plant 2 Site

CH2MHILL



WELL HEAD DETAIL

1/4"=1'-0"

FIGURE 5
Well Head Configuration
OMC Plant 2 Site

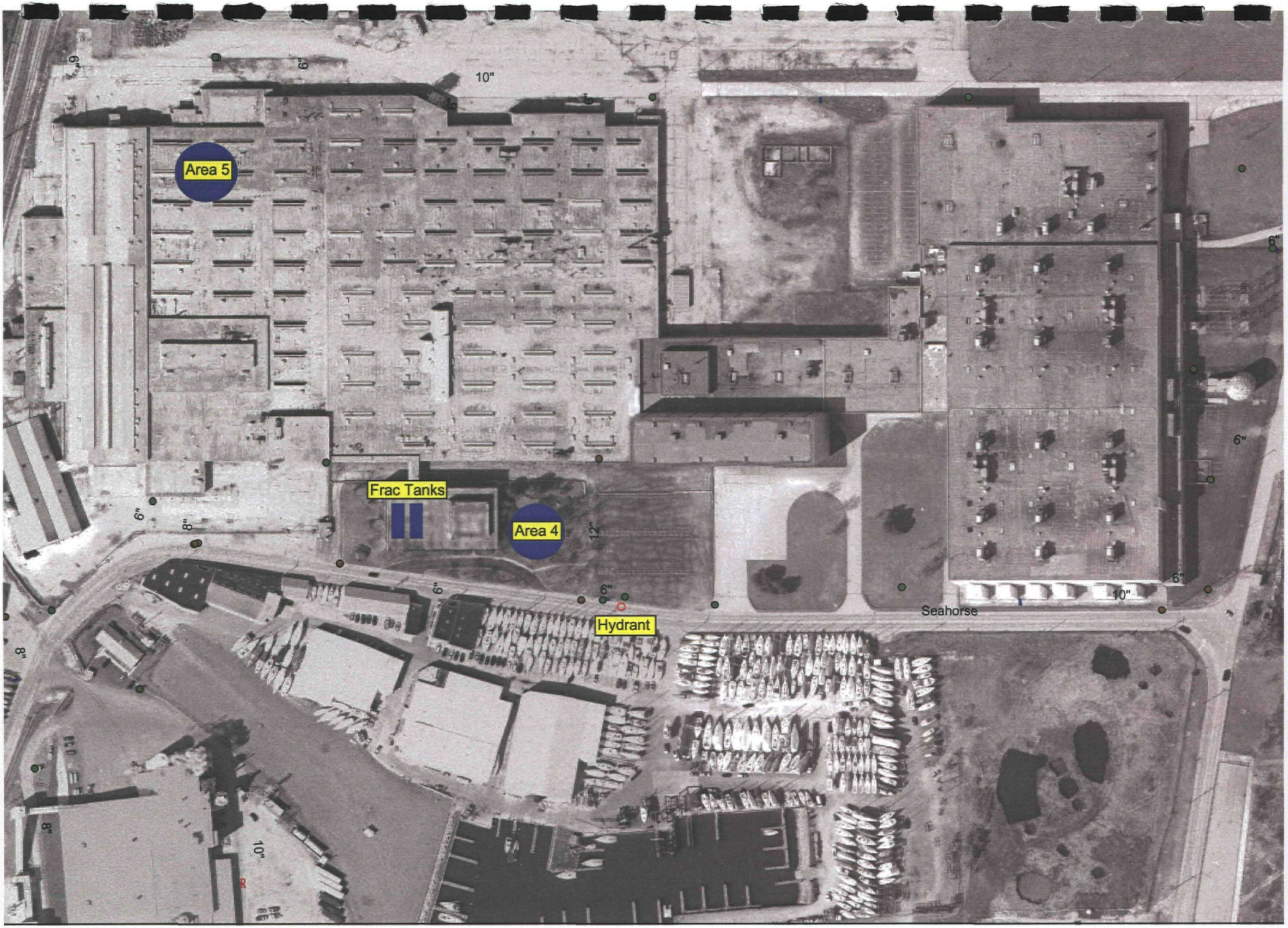
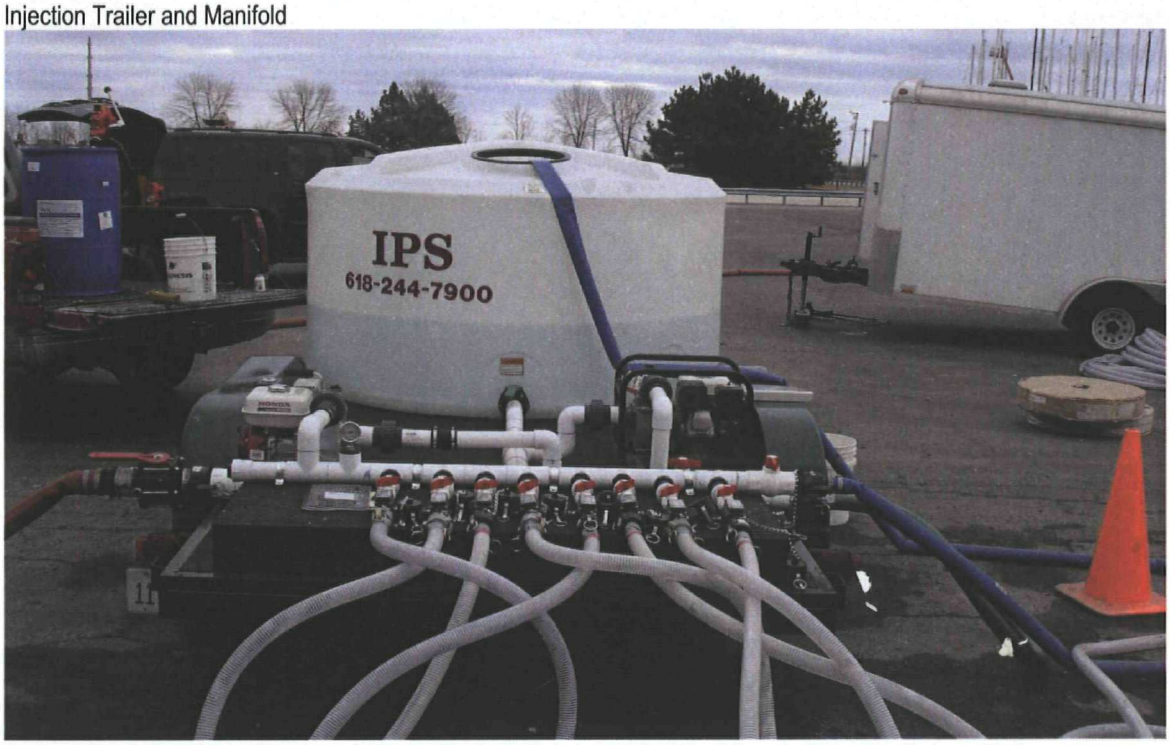


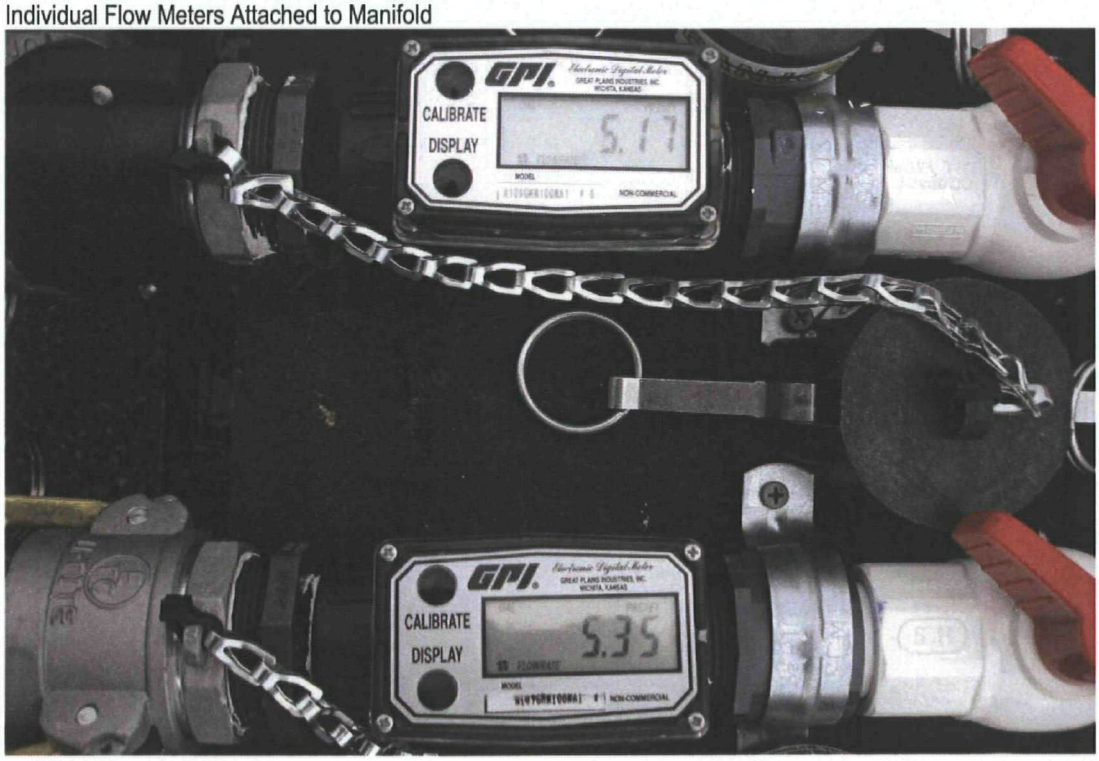
FIGURE 6
Site Layout
OMC Plant 2 Site

Appendix A
Photographs

PHOTOGRAPH 1
Injection Trailer and Manifold

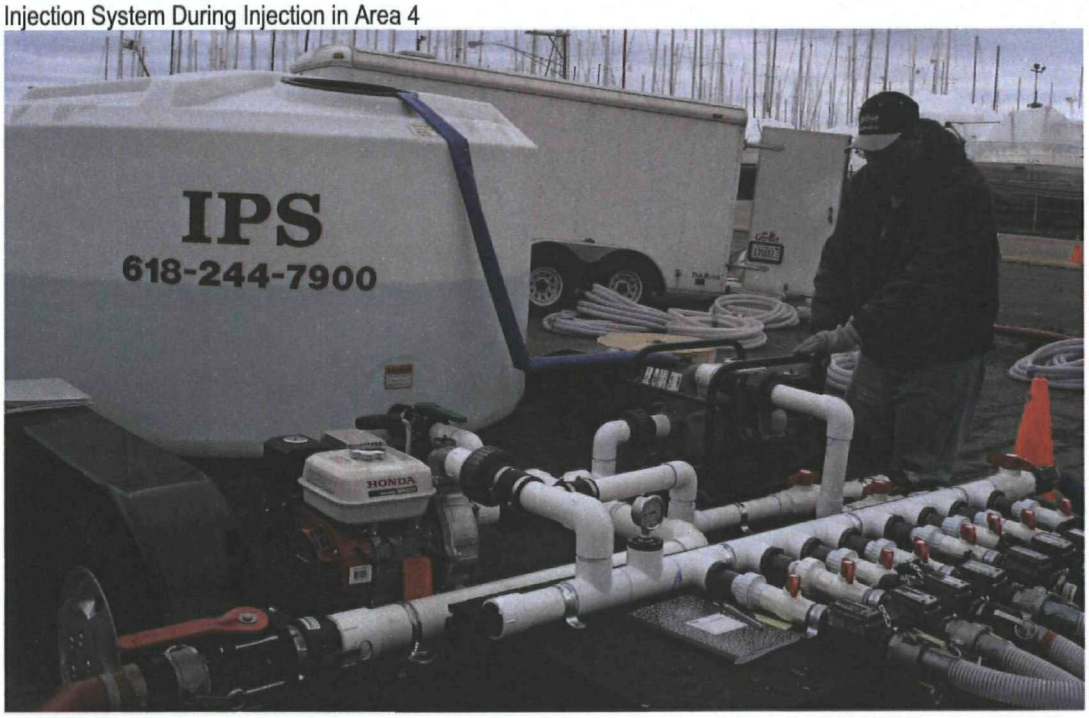


PHOTOGRAPH 2
Individual Flow Meters Attached to Manifold

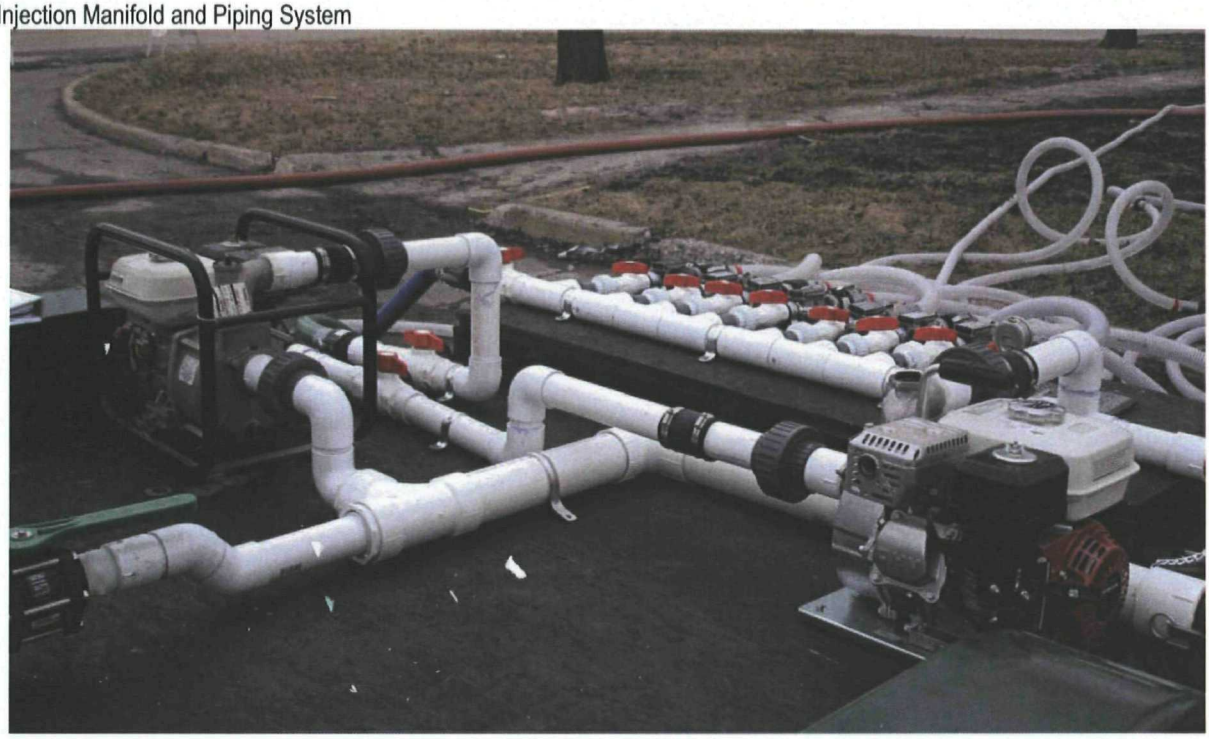


PHOTOGRAPH 5
Wellhead Attachment Connected to Well

PHOTOGRAPH 6
Injection System During Injection in Area 4



PHOTOGRAPH 3
Injection Manifold and Piping System



PHOTOGRAPH 4
Tubing Associated with Injection in Area 4

Appendix B
Depth to Water Readings

EOS® AND SODIUM LACTATE INJECTION PILOT STUDY SYSTEM DEPTH TO WATER COLLECTION FORM

USEPA

OMC Plant 2, Waukegan, Illinois

Date: March-07

Weather Conditions: sunny

Well ID - Area 4	DTW (ft) Time (Date)							
	1430 (3/14)	1525 (3/14)	1630 (3/14)	1025 (3/15)	1435 (3/15)	0815 (3/16)	0925 (3/16)	1110 (3/16)
IW-409	3.01	2.51	2.30	2.20	NM	NM	NM	NM
IW-403	3.20	2.84	2.69	2.59	NM	2.55	2.30	2.02
IW-402	3.29	3.03	2.90	2.73	1.89	NM	NM	NM
IW-401	3.34	3.03	2.90	2.74	NM	2.79	2.42	2.25
IW-405	4.45	4.08	3.94	3.65	3.50	NM	NM	NM
IW-415	3.77	3.50	3.36	3.15	NM	NM	3.51	NM
IW-411	4.17	3.69	3.44	3.19	NM	3.70	3.20	3.00
IW-417	3.59	3.34	3.10	2.81	NM	3.24	2.90	NM
IW-418	3.17	2.95	2.80	2.95	NM	NM	NM	NM
IW-419	2.71	2.55	2.38	2.22	NM	2.38	NM	NM
IW-413	3.19	2.75	2.59	2.46	NM	2.99	NM	NM
IW-407	3.69	3.30	3.12	2.93	NM	2.86	2.53	2.54
IW-408	3.38	NM	NM	NM	1.80	2.94	2.34	2.11
IW-406	4.07	NM	NM	NM	2.70	3.39	3.03	2.90
IW-400	NM	NM	NM	NM	3.75	3.44	NM	NM
IW-410	4.45	NM	NM	NM	3.08	NM	NM	NM
IW-416	3.64	NM	NM	NM	2.32	3.40	3.01	NM
IW-412	3.56	NM	NM	NM	1.71	3.02	2.52	2.25

EOS® AND SODIUM LACTATE INJECTION PILOT STUDY SYSTEM DEPTH TO WATER COLLECTION FORM

USEPA

OMC Plant 2, Waukegan, Illinois

Well ID - Area 5	DTW (ft) Time (Date)		
	0825 (3/22)	1030 (3/23)	1420 (3/23)
IW-502	4.33	NM	NM
IW-500	4.47	NM	NM
IW-512	4.51	NM	NM
IW-510	4.62	NM	NM
IW-511	4.5	3.03	NM
IW-509	4.57	NM	NM
IW-508	4.63	NM	NM
IW-507	4.68	NM	NM
IW-506	4.78	NM	3.36
IW-505	4.67	NM	3.32
IW-504	4.58	NM	NM
IW-520	4.72	2.82	NM
IW-518	4.73	2.99	NM
IW-516	4.81	3.39	NM
IW-514	4.59	3.74	2.93
IW-521	4.81	3.06	NM
IW-529	4.88	NM	NM
IW-528	4.88	2.63	NM
IW-527	4.91	NM	NM
IW-524	4.69	3.92	3.07

*DTW meter could not read DTW after EOS had been added

SODIUM LACTATE INJECTION PILOT STUDY SYSTEM DEPTH TO WATER COLLECTION FORM

USEPA

OMC Plant 2, Waukegan, Illinois

Date: June-07

Weather Conditions: sunny 70°F

Well ID - Area 4	DTW (ft) Time (Date)									
	0820 (6/13)	1005 (6/13)	1055 (6/13)	1200 (6/13)	1415 (6/13)	1515 (6/13)	1635 (6/13)	0740 (6/14)	0910 (6/14)	1030 (6/14)
IW-409	3.24	2.52	2.34	NM	2.15	1.90	1.50	NM	NM	NM
IW-403	3.42	2.85	2.69	2.42	NM	NM	NM	2.71	2.44	NM
IW-402	3.51	3.03	2.90	NM	2.18	1.87	NM	NM	NM	NM
IW-401	3.59	3.01	2.79	NM	NM	NM	NM	2.91	2.53	NM
IW-405	4.55	3.9	3.62	NM	3.59	3.38	NM	NM	NM	NM
IW-415	NM	3.41	3.20	3.02	NM	NM	NM	3.62	NM	3.26
IW-411	4.34	3.34	3.09	2.84	NM	NM	NM	2.72	3.47	3.34
IW-417	3.81	3.21	3.01	2.79	NM	NM	NM	3.27	2.97	2.75
IW-418	3.39	2.94	2.82	2.61	1.95	1.44	NM	NM	NM	NM
IW-419	2.90	2.60	2.45	2.29	NM	NM	NM	2.38	2.18	1.95
IW-413	3.44	2.65	2.49	2.28	NM	NM	NM	2.73	2.39	NM
IW-407	3.90	3.11	2.91	NM	NM	NM	NM	3.01	2.51	NM
IW-414	2.18	NM	NM	NM	1.18	0.81	0.70	1.62	1.37	1.21
IW-404	2.79	NM	NM	NM	1.94	1.75	1.43	2.03	1.80	NM
IW-408	3.59	NM	NM	NM	NM	1.98	1.53	2.90	2.60	2.51
IW-406	4.20	NM	NM	NM	2.71	2.39	NM	3.47	3.03	NM
IW-400	4.41	NM	NM	NM	3.80	3.64	NM	3.88	3.56	NM
IW-410	4.65	NM	NM	NM	3.28	2.91	2.74	4.03	3.84	3.68
IW-416	3.80	NM	NM	NM	2.35	1.96	1.70	3.33	3.09	2.94
IW-412	3.73	NM	NM	NM	1.90	1.42	1.05	2.97	2.71	2.55

SODIUM LACTATE INJECTION PILOT STUDY SYSTEM DEPTH TO WATER COLLECTION FORM

USEPA

OMC Plant 2, Waukegan, Illinois

Date: September-07

Weather Conditions: sunny

Well ID - Area 4	DTW (ft) Time (Date)								
	0715 (9/18)	1230 (9/18)	1320 (9/18)	1447 (9/18)	1649 (9/18)	1821 (9/18)	0740 (9/19)	0855 (9/19)	0945 (9/19)
IW-409	3.43	2.66	2.42	2.21	2.19	1.84	NM	NM	NM
IW-403	3.66	2.96	2.75	2.52	NM	NM	3.07	2.62	NM
IW-402	3.73	3.16	2.96	2.64	2.26	NM	NM	NM	NM
IW-401	3.81	3.11	2.89	2.59	NM	NM	3.24	2.80	2.69
IW-405	4.81	3.99	3.79	3.49	3.65	3.52	NM	NM	NM
IW-415	4.13	3.49	3.32	3.03	NM	NM	3.72	3.54	3.45
IW-411	4.53	3.35	3.11	2.79	NM	NM	3.91	3.58	3.46
IW-417	4.00	3.32	3.08	2.76	NM	NM	3.40	3.14	2.93
IW-418	3.58	3.08	2.86	2.59	1.89	1.46	NM	NM	NM
IW-419	3.16	2.76	2.53	2.30	NM	NM	2.61	2.33	2.21
IW-413	3.59	2.87	2.58	2.29	NM	NM	2.91	2.53	2.39
IW-407	4.13	3.15	2.92	2.60	NM	NM	3.38	2.91	2.75
IW-414	2.40	NM	NM	NM	1.09	0.70	1.79	1.53	1.40
IW-404	3.01	NM	NM	NM	1.99	1.72	2.61	2.01	1.89
IW-408	3.80	NM	NM	NM	2.19	1.69	3.02	2.65	2.51
IW-406	4.46	NM	NM	NM	2.68	2.56	3.84	3.31	3.14
IW-400	4.70	NM	NM	NM	3.88	3.75	4.33	4.01	3.83
IW-410	4.88	NM	NM	NM	3.24	2.94	4.36	4.02	3.91
IW-416	3.98	NM	NM	NM	2.26	1.97	3.48	3.25	3.14
IW-412	3.93	NM	NM	NM	1.84	1.33	3.24	2.88	2.74

SODIUM LACTATE INJECTION PILOT STUDY SYSTEM DEPTH TO WATER COLLECTION FORM

USEPA

OMC Plant 2, Waukegan, Illinois

Date: January-08

Weather Conditions: heavy rain, 50F

Well ID - Area 4	DTW (ft) Time (Date)					
	0830 (initial)	1215	1310	1330	1410	1530
MW-514S	2.95	2.85	2.79	2.74	2.65	2.60
MW-514D	2.95	2.85	2.79	2.66	2.59	2.61
IW-419	2.9	2.67	2.69	2.53	2.45	NM
IW-418	3.3	3	3.08	2.73	2.78	NM
IW-417	3.8	3.34	3.52	NM	NM	NM
IW-416	3.74	NM	NM	2.81	NM	NM
IW-415	3.66	3.6	3.67	3.43	3.5	NM
MW-527D	2.59	2.20	2.36	2.22	2.25	2.25
MW-527S	2.55	2.35	2.36	2.19	2.18	2.17
MW-528D	4.56	4.50	4.46	4.44	4.4	4.35
MW-528S	4.58	4.51	4.49	4.48	4.46	4.37
IW-410	4.61	NM	NM	NM	NM	NM
IW-411	4.28	3.59	4.02	NM	NM	NM
MW-529S	4.19	3.89	3.98	3.62	3.79	3.88
MW-529D	4.32	3.74	4.08	3.05	3.75	3.91
IW-412	3.76	NM	NM	2.64	NM	NM
IW-413	3.74	2.85	3.09	NM	NM	NM
IW-414	2.10	NM	NM	1.74	NM	NM
IW-404	2.71	NM	NM	2.45	NM	NM
IW-409	3.14	2.55	2.94	2.49	NM	NM
IW-408	3.50	NM	NM	NM	NM	NM
IW-403	3.36	3.09	3.22	NM	NM	NM
IW-402	3.45	3.19	3.29	3.01	NM	NM
IW-407	3.85	3.28	3.64	3.12	NM	NM
IW-406	4.17	NM	NM	3.61	NM	NM
IW-401	3.52	3.03	3.36	3.22	NM	NM
IW-400	4.39	4.27	4.29	4.24	NM	NM
IW-405	4.52	4.09	4.36	4.11	NM	NM

Appendix C

Pilot Study Performance Data

EOS® and Sodium Lactate Injection Pilot Study System Performance Data Collection Form
USEPA
OMC Plant 2, Waukegan, Illinois

Date: March-07 By: Christie Walker / Crispin Ngoma

Weather Conditions: sunny

Substrate drum Heater on (y/n) no

Transfer Pump Running (y/n) sometimes

Injection WELLS - Area 4 Time: 14:50 Date: 3/14/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	0	0	2	2	1	1	2	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.63	10.06	9.69	10.24	10.34	10.32	10.23	10.07
Total Volume into well (gallons)	136	99	127	125	128	131	123	120
Injection Start Time	2:45	2:45	2 45	2:45	2 45	2:45	2:45	2.45
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 15:00 Date: 3/14/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	NM	NM	1	NM	NM	NM	NM	NM
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.32	9.93	10.03	9.63	10.71	10.16	9.8	9.74
Total Volume into well (gallons)	222	183	213	208	220	223	213	212
Injection Start Time	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 15:20 Date: 3/14/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	0	0	2	4	2	2	2	2
Gate Valve Open (Y/N)	y	y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	9.33	8.65	8.79	8.34	10.45	9.48	8.97	9
Total Volume into well (gallons)	336	278	313	306	327	316	315	315
Injection Start Time	2:45	2 45	2:45	2:45	2:45	2:45	2:45	2:45
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 16:00 Date: 3/14/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	1	0	2	4	2	3	2	4
Gate Valve Open (Y/N)	y	y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.68	10.38	11.13	10.01	9.43	10.49	10.86	10.09
Total Volume into well (gallons)	608	497	598	547	563	572	560	573
Injection Start Time	2 45	2:45	2.45	2:45	2 45	2.45	2:45	2:45
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1650 Date: 3/14/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	NM	NM	NM	NM
Gate Valve Open (Y/N)	y	y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	8.22	7.15	7.19	6.61	7.17	7.06	6.94	7.07
Total Volume into well (gallons)	975	834	983	878	900	926	924	926
Injection Start Time	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45
Injection End Time	1650	1650	1650	1650	1650	1650	1650	1650

EOS® and Sodium Lactate Injection Pilot Study System Performance Data Collection Form
USEPA
OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4	Time: 9:50	Date: 3/15/2007		Substrate	Lactate			
Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	2	1	NM	6	2	2	2	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.3	10.7	10 3	9.87	10.27	10.52	9.87	10.54
Total Volume into well (gallons)	1230	1159	1240	1146	1160	1175	1176	1171
Injection Start Time	9:45	9:45	9:45	9:45	9 45	9:45	9:45	9 45
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4	Time: 10:46	Date: 3/15/2007		Substrate	Lactate			
Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	2	1	1	2	1	2	2	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.88	10.47	10.1	11.61	11.71	10.01	11.19	10 49
Total Volume into well (gallons)	1688	1588	1675	1544	1581	1570	1606	1588
Injection Start Time	NA	NA	NA	NA	NA	NA	NA	NA
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4	Time: 1140	Date: 3/15/2007		Substrate	Lactate			
Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	NM	NM	NM	NM
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10	10	10	10	10	10	10	10
Total Volume into well (gallons)	2247	2247	3121.2	3121.8	3121	3121.19	3128	3125
Injection Start Time	NA	NA	NA	NA	NA	NA	NA	NA
Injection End Time	1140	1146	1301	1314	1317	1316	1318	1311

Injection WELLS - Area 4	Time: 1430	Date: 3/15/2007		Substrate	Lactate			
Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	2	2	0	2	2	2	3	0
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.44	10.43	10.52	11.75	10.27	10.39	10.48	11.19
Total Volume into well (gallons)	1587	1657	389	492	401	463	403	457
Injection Start Time	12:00	12.03	13:40	13:40	13:40	13 40	13:40	13:40
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4	Time: 1600	Date: 3/15/2007		Substrate	Lactate			
Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	3	4	2	2	3	5	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.7	10.87	15.12	13.79	9.36	12.67	11.87	13.53
Total Volume into well (gallons)	2948	3105	2092	2247	1725	2053	1987	2171
Injection Start Time	12:00	12:03	13 40	13 40	13:40	13:40	13:40	13:40
Injection End Time	NA	NA	NA	1650	NA	NA	NA	NA

EOS® and Sodium Lactate Injection Pilot Study System Performance Data Collection Form
USEPA
OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4	Time: 1630	Date: 3/15/2007		Substrate	Lactate			
Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	2	7	7	8
Gate Valve Open (Y/N)	Y	Y	Y	NM	Y	Y	Y	Y
Flow Rate (gpm)	0	0	0	NM	17.22	23.18	23.14	26.9
Total Volume into well (gallons)	2121	3121.02	2250	NM	NM	NM	NM	NM
Injection Start Time	12:00	12:03	13.40	NM	13.40	13:40	13:40	13 40
Injection End Time	17.00	16:51	16:58	NM	NA	NA	NA	NA

Injection WELLS - Area 4	Time: 1140	Date: 3/15/2007		Substrate	Lactate			
Well ID and zone / Parameter	IP-# 404 shallow	IP-#400 shallow	IP-#414 deep	IP-#408 deep	IP-#406 deep	IP-#410 deep	IP-#416 deep	IP-# 412 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	NM	NM	NM	NM
Gate Valve Open (Y/N)	NM	NM	NM	NM	NM	NM	NM	NM
Flow Rate (gpm)	NM	NM	NM	NM	NM	NM	NM	NM
Total Volume into well (gallons)	NM	NM	NM	NM	3121	3121	3121.02	3129
Injection Start Time	NM	NM	NM	NM	13 40	13:40	13 40	13 40
Injection End Time	NM	NM	NM	NM	18:20	17:41	18:10	17:30

Injection WELLS - Area 4	Time: 08:50	Date: 3/15/2007	Substrate	Lactate
Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	2	2	6	4
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	15.01	14.98	14.7	15.18
Total Volume into well (gallons)	465	487	450	519
Injection Start Time	8:15	8 15	8:15	8:15
Injection End Time	NA	NA	NA	NA

Injection WELLS - Area 4	Time: 0916	Date: 3/15/2007	Substrate	Lactate
Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 shallow
Wellhead Pressure (psi)	2	2	6	5
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	14.92	15.13	14.74	14.78
Total Volume into well (gallons)	977	1003	961	1033
Injection Start Time	8 15	8:15	8.15	8.15
Injection End Time	NA	NA	NA	NA

EOS® and Sodium Lactate Injection Pilot Study System Performance Data Collection Form
USEPA
OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4	Time: 1030	Date: 3/15/2007	Substrate	Lactate
Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 shallow	IP-#418 deep
Wellhead Pressure (psi)	NM	NM	NM	NM
Gate Valve Open (Y/N)	Y	N	Y	Y
Flow Rate (gpm)	15.56	0	15.93	15.68
Total Volume into well (gallons)	2258	2247.36	2234	2272
Injection Start Time	8:15	8 15	8 15	8.15
Injection End Time	NA	10:50	NA	NA

Injection WELLS - Area 4	Time: 1140	Date: 3/15/2007	Substrate	Lactate
Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	3	NM	6	3
Gate Valve Open (Y/N)	Y	NM	Y	Y
Flow Rate (gpm)	21.65	NM	16.61	21.49
Total Volume into well (gallons)	2812/3121	NM	2751/3121	2872/3121
Injection Start Time	8 15	NM	8:15	8:15
Injection End Time	1140	NM	1145	1135

Injection WELLS - Area 5	Time: 0925	Date: 3/15/2007			Substrate: EOS			
Well ID and zone / Parameter	IP-# 504 deep	IP-#506 deep	IP-#508 deep	IP-#510 deep	IP-#512 deep	IP-#531 deep	IP-#529 deep	IP-#527 deep
Wellhead Pressure (psi)	2	2	4	2	3	3	2	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	11.34	12.55	12.05	12.61	12.07	12.04	12.32	12.58
Total Volume into well (gallons)	120 (from previous day)	120 (from previous day)	120 (from previous day)	120 (from previous day)	120 (from previous day)	120 (from previous day)	120 (from previous day)	120 (from previous day)
Injection Start Time	9:25	9:25	9:25	9:25	9:25	9:25	9:25	9:25
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 5	Time: 1130	Date: 3/15/2007			Substrate: EOS			
Well ID and zone / Parameter	IP-# 504 deep	IP-#506 deep	IP-#508 deep	IP-#510 deep	IP-#512 deep	IP-#531 deep	IP-#529 deep	IP-#527 deep
Wellhead Pressure (psi)	3	2	3	2	2	4	3	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	14.31	14	13.46	14.17	13.3	13.18	14.15	13 72
Total Volume into well (gallons)	120+1632	120+1665	120+1580	120+1640	120+1618	120+1575	120+1617	120+1617
Injection Start Time	9:25	9:25	9:25	9.25	9:25	9:25	9 25	9:25
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 5	Time: 1240	Date: 3/15/2007			Substrate: EOS			
Well ID and zone / Parameter	IP-# 504 deep	IP-#506 deep	IP-#508 deep	IP-#510 deep	IP-#512 deep	IP-#531 deep	IP-#529 deep	IP-#527 deep
Wellhead Pressure (psi)	0	0	0	0	0	0	0	0
Gate Valve Open (Y/N)	N	N	N	N	N	N	N	N
Flow Rate (gpm)	0	0	0	0	0	0	0	0
Total Volume into well (gallons)	2528	2528	2528	2528	2528	2528	2528	2528
Injection Start Time	9:25	9:25	9:25	9:25	9:25	9:25	9:25	9:25
Injection End Time	12:40	12 50	12 50	12.50	12.50	12:50	12:50	12:50

EOS® and Sodium Lactate Injection Pilot Study System Performance Data Collection Form
USEPA
OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 5 Time: 1345 Date: 3/15/2007 Substrate: EOS

Well ID and zone / Parameter	IP-# 513 shallow	IP-#515 shallow	IP-#517 shallow	IP-#521 shallow	IP-#535 deep	IP-#533 deep	IP-#537 deep	IP-#519 shallow
Wellhead Pressure (psi)	0	0	0	0	2	1	2	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	14.98	14.56	13.15	13.71	13.43	13.31	14.77	14.32
Total Volume into well (gallons)	228	226	232	216	226	219	220	230
Injection Start Time	13:25	13:25	13:25	13:25	13:25	13:25	13:25	13:25
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 5 Time: 1505 Date: 3/15/2007 Substrate: EOS

Well ID and zone / Parameter	IP-# 513 shallow	IP-#515 shallow	IP-#517 shallow	IP-#521 shallow	IP-#535 deep	IP-#533 deep	IP-#537 deep	IP-#519 shallow
Wellhead Pressure (psi)	0	0	0	1	2	0	2	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	13.42	13.42	13.48	13.36	13.76	15.73	13.32	14.54
Total Volume into well (gallons)	1185	1176	1175	1147	1193	1233	1196	1169
Injection Start Time	13:25	13:25	13:25	13:25	13:25	13:25	13:25	13:25
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 5 Time: 1330 Date: 3/15/2007 Substrate: EOS

Well ID and zone / Parameter	IP-# 513 shallow	IP-#515 shallow	IP-#517 shallow	IP-#521 shallow	IP-#535? deep	IP-#533 deep	IP-#537 deep	IP-#519 shallow
Wellhead Pressure (psi)	0	0	0	0	4	3	4	0
Gate Valve Open (Y/N)	N	N	N	N	Y	Y	Y	N
Flow Rate (gpm)	0	0	0	0	22.54	22.16	22.27	0
Total Volume into well (gallons)	1264	1264	1264	1264	2528	2528	2528	1264
Injection Start Time	13:25	13:25	13:25	13:25	13:25	13:25	13:25	13:25
Injection End Time	15:12	15:12	15:12	15:12	16:05	16:05	16:05	15:12

Injection WELLS - Area 5 Time: 1400 Date: 3/15/2007 Substrate: EOS

Well ID and zone / Parameter	IP-# 514 shallow	IP-#522 shallow	IP-#516 shallow	IP-#520 shallow	IP-#518 shallow
Wellhead Pressure (psi)	2	1	2	1	0
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y
Flow Rate (gpm)	15.75	10.35	14.81	18.68	19.57
Total Volume into well (gallons)	451	315	434	460	434
Injection Start Time	13:50	13:50	13:50	13:50	13:50
Injection End Time	NA	NA	NA	NA	NA

Injection WELLS - Area 5 Time: 1510 Date: 3/15/2007 Substrate: EOS

Well ID and zone / Parameter	IP-# 514 shallow	IP-#522 shallow	IP-#516 shallow	IP-#520 shallow	IP-#518 shallow
Wellhead Pressure (psi)	0	0	0	0	0
Gate Valve Open (Y/N)	N	N	N	N	N
Flow Rate (gpm)	0	0	0	0	0
Total Volume into well (gallons)	1264	1264	1264	1265.9	1264.2
Injection Start Time	13:50	13:50	13:50	13:50	13:50
Injection End Time	15:11	15:20	15:12	15:09	15:10

EOS® and Sodium Lactate Injection Pilot Study System Performance Data Collection Form
USEPA
OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 5	Time: 0900	Date: 3/15/2007		Substrate: EOS	
Well ID and zone / Parameter	IP-# 525 DEEP	IP-#523 DEEP	IP-#532 DEEP	IP-#536 DEEP	IP-#534 DEEP
Wellhead Pressure (psi)	6	2	2	2	0
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.74	11.22	11.53	11.58	11
Total Volume into well (gallons)	256	279	283	300	302
Injection Start Time	8:30	8:30	8:30	8:30	8:30
Injection End Time	NA	NA	NA	NA	NA

Injection WELLS - Area 5	Time: 1035	Date: 3/15/2007		Substrate: EOS	
Well ID and zone / Parameter	IP-# 525 DEEP	IP-#523 DEEP	IP-#532 DEEP	IP-#536 DEEP	IP-#534 DEEP
Wellhead Pressure (psi)	6	2	4	4	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y
Flow Rate (gpm)	18.8	18.33	19.75	19.89	21.02
Total Volume into well (gallons)	1456/2528	1798/2528	1880/2528	1880/2528	1901/2528
Injection Start Time	8:30	8:30	8:30	8:30	8:30
Injection End Time	11:29	11:30	11:25	11:26	11:28

Injection WELLS - Area 5	Time: 0825	Date: 3/15/2007			Substrate: EOS			
Well ID and zone / Parameter	IP-# 524 shallow	IP-#505 shallow	IP-#526 shallow	IP-#507 shallow	IP-#511 shallow	IP-#530 shallow	IP-#528 shallow	IP-#509 shallow
Wellhead Pressure (psi)	0	1	2	2	4	2	0	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.08	10.2	10.85	9.08	10.48	9.93	8.83	8.96
Total Volume into well (gallons)	199	186	185	182	205	188	197	198
Injection Start Time	8:25	8:25	8:25	8:25	8:25	8:25	8:25	8:25
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 5	Time: 0955	Date: 3/15/2007			Substrate: EOS			
Well ID and zone / Parameter	IP-# 524 shallow	IP-#505 shallow	IP-#526 shallow	IP-#507 shallow	IP-#511 shallow	IP-#530 shallow	IP-#528 shallow	IP-#509 shallow
Wellhead Pressure (psi)	0	1	2	2	2	3	0	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	13.67	13.39	14.27	13.44	13.17	13.34	14.1	14.44
Total Volume into well (gallons)	996	1023	1007	1017	1084	981	1145	1129
Injection Start Time	8:25	8:25	8:25	8:25	8:25	8:25	8:25	8:25
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 5	Time: 12:00	Date: 3/15/2007			Substrate: EOS			
Well ID and zone / Parameter	IP-# 524 shallow	IP-#505 shallow	IP-#526 shallow	IP-#507 shallow	IP-#511 shallow	IP-#530 shallow	IP-#528 shallow	IP-#509 shallow
Wellhead Pressure (psi)	0	0	0	0	0	0	0	0
Gate Valve Open (Y/N)	N	N	N	N	N	N	N	N
Flow Rate (gpm)	0	0	0	0	0	0	0	0
Total Volume into well (gallons)	2528.6	2528	2528.5	2528	2528	2528	2529	2530
Injection Start Time	8:25	8:25	8:25	8:25	8:25	8:25	8:25	8:25
Injection End Time	11:59	12:11	12:06	12:12	11:55	12:10	12:05	11:57

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

USEPA

OMC Plant 2, Waukegan, Illinois

Date: June-07 By: C. Fehn & C. Walker

Weather Conditions: sunny 75°F

Substrate drum Heater on (y/n) No

Transfer Pump Running (y/n) sometimes

Injection WELLS - Area 4 Time: 0950 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#408	IP-#406	IP-#410	IP-#412	IP-#416	IP-# 414
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	1	0	6	4	3	4	5	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	14.07	13.31	13.59	13.84	14.12	13.89	14.15	13.66
Total Volume into well (gallons)	240	263	272	245	266	270	274	283
Injection Start Time	9:35	9:35	9:35	9:35	9:35	9:35	9:35	9:35
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1020 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#408	IP-#406	IP-#410	IP-#412	IP-#416	IP-# 414
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	3	0	5	4	4	4	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	13.31	13.44	15.73	13.57	13.58	13.62	13.49	13.55
Total Volume into well (gallons)	619	644	672	625	646	650	652	656
Injection Start Time	9:35	9:35	9:35	9:35	9:35	9:35	9:35	9:35
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1050 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#408	IP-#406	IP-#410	IP-#412	IP-#416	IP-# 414
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	2	0	4	4	4	3	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	13.34	13.49	15.39	13.27	14.22	13.79	13.79	13.80
Total Volume into well (gallons)	996	1026	1107	1113	1041	1043	1042	1049
Injection Start Time	9:35	9:35	9:35	9:35	9:35	9:35	9:35	9:35
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1130 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#408	IP-#406	IP-#410	IP-#412	IP-#416	IP-# 414
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	1	0	4	4	4	3	3	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	13.39	13.61	13.75	13.60	13.96	13.85	13.88	13.83
Total Volume into well (gallons)	1616	1651	1743	1632	1677	1674	1681	1683
Injection Start Time	9:35	9:35	9:35	9:35	9:35	9:35	9:35	9:35
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form
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OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4 Time: 1220 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#408	IP-#406	IP-#410	IP-#412	IP-#416	IP-# 414
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	2	0	3	4	4	4	3	6
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	NA	NA	15.61	15.14	15.28	15.57	15.11	15.90
Total Volume into well (gallons)	2247	2247	2458	2326	2395	2389	2389	2395
Injection Start Time	9:35	9:35	9:35	9:35	9:35	9:35	9:35	9:35
Injection End Time	12:23	12:20	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1315 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#408	IP-#406	IP-#410	IP-#412	IP-#416	IP-# 414
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)			1	NM	NM	NM	NM	1
Gate Valve Open (Y/N)			Y	Y	Y	Y	Y	Y
Flow Rate (gpm)			NM	NM	NM	NM	NM	NM
Total Volume into well (gallons)			3121	3121	3122	3121	3121	3121
Injection Start Time			9:35	9:35	9:35	9:35	9:35	9:35
Injection End Time			13:15	13:40	13:30	13:20	13:19	13:17

Injection WELLS - Area 4 Time: 1420 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 403	IP-#401	IP-#407	IP-#411	IP-#413	IP-#417	IP-#419	IP-# 415
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	2	0	5	3	4	5	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	12.71	13.39	14.51	14.64	14.42	14.21	14.05	14.13
Total Volume into well (gallons)	241	224	200	57	206	191	65	218
Injection Start Time	14:04	14:04	14:04	14:04	14:04	14:04	14:04	14:04
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1449 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 403	IP-#401	IP-#407	IP-#411	IP-#413	IP-#417	IP-#419	IP-# 415
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	3	0	3	3	4	5	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	12.66	13.17	14.67	14.60	14.45	14.26	13.87	14.28
Total Volume into well (gallons)	616	611	620	475	619	600	469	628
Injection Start Time	14:04	14:04	14:04	14:04	14:04	14:04	14:04	14:04
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1529 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 403	IP-#401	IP-#407	IP-#411	IP-#413	IP-#417	IP-#419	IP-# 415
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	3	0	3	4	4	4	5	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	12.48	12.71	13.72	14.55	13.63	13.81	15.83	14.18
Total Volume into well (gallons)	1117	1133	1203	1079	1190	1163	1077	1193
Injection Start Time	14:04	14:04	14:04	14:04	14:04	14:04	14:04	14:04
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

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OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4 Time: 1608 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 403 shallow	IP-#401 shallow	IP-#407 deep	IP-#411 deep	IP-#413 deep	IP-#417 deep	IP-#419 deep	IP-# 415 deep
Wellhead Pressure (psi)	4	0	5	4	5	6	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	15.60	13.25	14.56	12.84	14.12	14.21	12.92	14.16
Total Volume into well (gallons)	1765	1693	1818	1637	1789	1762	1643	1794
Injection Start Time	14:04	14:04	14:04	14:04	14:04	14:04	14:04	14:04
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1650 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 403 shallow	IP-#401 shallow	IP-#407 deep	IP-#411 deep	IP-#413 deep	IP-#417 deep	IP-#419 deep	IP-# 415 deep
Wellhead Pressure (psi)	4	0	4	6	6	6	6	6
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	15.21	18.23	13.92	11.85	13.63	13.46	12.15	13.20
Total Volume into well (gallons)	2024	2149	2365	2113	2315	2291	2123	2320
Injection Start Time	14:04	14:04	14:04	14:04	14:04	14:04	14:04	14:04
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1730 Date: 6/13/2007 Substrate Lactate

Well ID and zone / Parameter	IP-# 403 shallow	IP-#401 shallow	IP-#407 deep	IP-#411 deep	IP-#413 deep	IP-#417 deep	IP-#419 deep	IP-# 415 deep
Wellhead Pressure (psi)	NA	NA	11	5	5	6	6	11
Gate Valve Open (Y/N)	N	N	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	NA	NA	8.53	16.22	18.07	18.09	15.22	9.24
Total Volume into well (gallons)	2387	2247	2856 (End 3121	2566 (End 3121	2818 (End 3132	2845 End (3156)	2628 (End 3121)	2792 (End 3121)
Injection Start Time	14:04	14:04	14:04	14:04	14:04	14:04	14:04	14:04
Injection End Time	16:53	16:57	17:51	17:53	17:45	17:50	17:57	17:55

Injection WELLS - Area 4 Time: 0755 Date: 6/14/07 Substrate Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	8	2	5	4
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	13.78	14.11	14.98	15.30
Total Volume into well (gallons)	386	425	374	408
Injection Start Time	7:30	7:30	7:30	7:30
Injection End Time	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 0830 Date: 6/14/07 Substrate Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	8	2	5	3
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	12.58	14.14	13.43	12.12
Total Volume into well (gallons)	779	823	726	773
Injection Start Time	7:30	7:30	7:30	7:30
Injection End Time	NA	NA	NA	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form
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OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4 Time: 0910 Date: 6/14/07 Substrate Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	8	1	5	3
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	12.47	14.29	13.50	12.02
Total Volume into well (gallons)	1231	1429	1301	1286
Injection Start Time	7:30	7:30	7:30	7:30
Injection End Time	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 0945 Date: 6/14/07 Substrate Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	7	2	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	10.53	23.60	17.89	18.77
Total Volume into well (gallons)	1911	2144	1904	1892
Injection Start Time	7:30	7:30	7:30	7:30
Injection End TIme	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1017 Date: 6/14/07 Substrate Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	10	0	6	4
Gate Valve Open (Y/N)	Y	N	Y	Y
Flow Rate (gpm)	17.57	0	17.01	16.74
Total Volume into well (gallons)	2436	2247	2401	2390
Injection Start Time	7:30	7:30	7:30	7:30
Injection End Time	NA	9:50	NA	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

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OMC Plant 2, Waukegan, Illinois

Date: September-07 By: C. Fehn & S. Paukner

Weather Conditions: sunny 75°F

Substrate drum Heater on (y/n) No

Transfer Pump Running (y/n) sometimes

Injection WELLS - Area 4 Time: 1212 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-# 416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	0	0	0	2	2	2	8	1
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	9.71	10.63	15.60	14.38	15.03	15.14	14.40	15.26
Total Volume into well (gallons)	481	448	551	562	502	579	553	565
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1239 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-# 416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	0	0	0	4	2	3	6	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	9.73	9.55	14.83	14.48	14.47	15.37	13.51	14.39
Total Volume into well (gallons)	730	706	934	922	873	954	902	939
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1305 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-# 416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	0	0	0	2	2	2	6	0
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.11	9.99	14.48	14.46	14.40	14.92	13.30	13.18
Total Volume into well (gallons)	981	954	1304	1294	1239	1333	1243	1231
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1330 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-# 416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	0	0	0	4	2	2	4	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.24	10.19	14.39	14.72	14.54	14.16	13.56	14.44
Total Volume into well (gallons)	1224	1192	1636	1632	1582	1667	1543	1641
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

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OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4 Time: 1350 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-#_416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	0	0	0	4	2	2	6	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.27	10.12	14.41	14.67	14.57	14.18	13.62	14.41
Total Volume into well (gallons)	1460	1423	1939	1962	1906	1978	1833	1954
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1415 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-#_416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	0	0	0	4	2	2	6	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.32	10.37	14.53	14.55	14.59	14.16	13.66	14.47
Total Volume into well (gallons)	1691	1654	2263	2286	2230	2295	2139	2277
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1435 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-#_416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	2	0	5	3	4	5	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.30	10.34	14.64	14.4	14.49	14.11	13.66	14.57
Total Volume into well (gallons)	1935	1899	2637	2634	2584	2647	2487	2642
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1500 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-#_404	IP-#400	IP-#414	IP-#408	IP-#406	IP-#410	IP-#_416	IP-# 412
	shallow	shallow	deep	deep	deep	deep	deep	deep
Wellhead Pressure (psi)	0	0	0	4	2	2	6	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	10.27	9.88	14.48	14.04	14.12	13.37	13.44	14.17
Total Volume into well (gallons)	2165	2124	2988	2961	2918	2968	2811	2983
Injection Start Time	12:12	12:12	12:12	12:12	12:12	12:12	12:12	12:12
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1606 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 407	IP-#411	IP-#401	IP-#403	IP-#415	IP-#413	IP-#417	IP-# 419
	deep	deep	shallow	shallow	deep	deep	deep	deep
Wellhead Pressure (psi)	2	6	1	0	5	6	7	3
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	11.68	15.03	15.68	11.62	14.16	15.51	14.71	15.35
Total Volume into well (gallons)	218	257	298	231	266	286	279	298
Injection Start Time	15:53	15:53	15:53	15:53	15:53	15:53	15:53	15:53
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

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OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4 Time: 1635 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	2	6	0	0	6	6	6	2
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	11.80	15.18	15.7	11.59	14.78	15.44	14.96	15.48
Total Volume into well (gallons)	614	762	823	623	752	799	765	801
Injection Start Time	15:53	15:53	15:53	15:53	15:53	15:53	15:53	15:53
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1721 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	4	0	4	6	6	6	6	6
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	11.76	15.08	15.73	11.77	14.94	15.16	14.74	15.30
Total Volume into well (gallons)	1090	1372	1458	1098	1360	1421	1376	1438
Injection Start Time	15:53	15:53	15:53	15:53	15:53	15:53	15:53	15:53
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1738 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	3	6	2	0	6	6	7	3
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	11.73	14.96	15.58	11.65	14.94	15.09	14.72	15.23
Total Volume into well (gallons)	1281	1613	1712	1288	1598	1660	1608	1678
Injection Start Time	15:53	15:53	15:53	15:53	15:53	15:53	15:53	15:53
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1756 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	3	6	2	0	6	6	7	3
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Flow Rate (gpm)	11.78	14.98	15.7	11.77	14.89	15.12	14.69	15.32
Total Volume into well (gallons)	1520	1917	2028	1527	1973	1904	1903	1982
Injection Start Time	15:53	15:53	15:53	15:53	15:53	15:53	15:53	15:53
Injection End Time	NA	NA	NA	NA	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1830 Date: 9/18/2007 Substrate: Lactate

Well ID and zone / Parameter	IP-# 407 deep	IP-#411 deep	IP-#401 shallow	IP-#403 shallow	IP-#415 deep	IP-#413 deep	IP-#417 deep	IP-# 419 deep
Wellhead Pressure (psi)	6	6		0	6	7	8	4
Gate Valve Open (Y/N)	Y	Y	N	Y	Y	Y	Y	Y
Flow Rate (gpm)	18.82	16.66		12.81	16.39	16.59	16.20	16.54
Total Volume into well (gallons)	2023	2435		1924	2417	2486	2418	2513
Injection Start Time	15:53	15:53		15:53	15:53	15:53	15:53	15:53
Injection End Time	NA	NA		NA	NA	NA	NA	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

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Injection WELLS - Area 4 Time: 0754 Date: 9/19/200 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	8	2	4	3
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	17.53	17.26	14.62	16.69
Total Volume into well (gallons)	408	386	280	381
Injection Start Time	7:35	7:35	7:35	7:35
Injection End Time	NA	NA	NA	NA

[redacted]s deep

[redacted]s shallow

Injection WELLS - Area 4 Time: 0822 Date: 9/19/200 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	7	2	4	2
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	15.73	16.19	13.48	15.70
Total Volume into well (gallons)	820	795	626	776
Injection Start Time	7:35	7:35	7:35	7:35
Injection End Time	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 0842 Date: 9/19/200 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	7	2	4	2
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	15.97	16.03	13.53	15.63
Total Volume into well (gallons)	1420	1421	1150	1389
Injection Start Time	7:35	7:35	7:35	7:35
Injection End Time	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 0900 Date: 9/19/200 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	7	2	4	4
Gate Valve Open (Y/N)	Y	Y	Y	Y
Flow Rate (gpm)	10.53	23.60	17.89	18.77
Total Volume into well (gallons)	1911	2144	1904	1892
Injection Start Time	7:35	7:35	7:35	7:35
Injection End Time	NA	NA	NA	NA

Injection WELLS - Area 4 Time: 1023 Date: 9/19/200 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-#402 shallow	IP-#405 deep	IP-#418 deep
Wellhead Pressure (psi)	8	2	0	3
Gate Valve Open (Y/N)	Y	Y	N	Y
Flow Rate (gpm)	16.12	17.45	0	17.21
Total Volume into well (gallons)	2673	2830	2247	2809
Injection Start Time	7:35	7:35	7:35	7:35
Injection End Time	NA	NA	10:18	NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form
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OMC Plant 2, Waukegan, Illinois

Date: January-08 By: C. Walker, S. Paukner

Weather Conditions: heavy rain, 50F

Substrate drum Heater on (y/n) No

Transfer Pump Running (y/n) sometimes

Injection WELLS - Area 4 Time: 1205 Date: 1/8/08 Substrate: Lactate

Well ID and zone / Parameter	Flow meter not operating	IP-# 412 deep	IP-# 416 deep	IP-# 414 deep	IP-# 406 deep	Flow meter not working		IP-# 404 shallow
Wellhead Pressure (psi)		0	2	2	2			2
Gate Valve Open (Y/N)		Y	Y	Y	Y			Y
Flow Rate (gpm)		0	0.00	0	0			0
Total Volume into well (gallons)		0	0	0	0			0
Injection Start Time		12:00	12:00	12:00	12:00			12:00
Injection End Time		NA	NA	NA	NA			NA

Injection WELLS - Area 4 Time: 1215 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	Flow meter not operating	IP-# 412 deep	IP-# 416 deep	IP-# 414 deep	IP-# 406 deep	Flow meter not working		IP-# 404 shallow
Wellhead Pressure (psi)		5	4	3	8			2
Gate Valve Open (Y/N)		Y	Y	Y	Y			Y
Flow Rate (gpm)		11.38	10.94	11.38	6.22			8.63
Total Volume into well (gallons)		140	137	140	140			145
Injection Start Time		NA	NA	NA	NA			NA
Injection End Time		N A	N A	N A	N A			N A

Injection WELLS - Area 4 Time: 1230 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	Flow meter not operating	IP-# 412 deep	IP-# 416 deep	IP-# 414 deep	IP-# 406 deep	Flow meter not working		IP-# 404 shallow
Wellhead Pressure (psi)		5	4	3	8			2
Gate Valve Open (Y/N)		Y	Y	Y	Y			Y
Flow Rate (gpm)		10.17	11.06	11.35	5.99			6.89
Total Volume into well (gallons)		284	294	299	285			253
Injection Start Time		NA	NA	NA	NA			NA
Injection End Time		NA	NA	NA	NA			NA

Injection WELLS - Area 4 Time: 1240 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	Flow meter not operating	IP-# 412 deep	IP-# 416 deep	IP-# 414 deep	IP-# 406 deep	Flow meter not working		IP-# 404 shallow
Wellhead Pressure (psi)		NM	NM	NM	NM			NM
Gate Valve Open (Y/N)		Y	Y	Y	Y			Y
Flow Rate (gpm)		6.61	9.04	8.94	7.34			6.02
Total Volume into well (gallons)		365	385	393	376			310
Injection Start Time		NA	NA	NA	NA			NA
Injection End Time		NA	NA	NA	NA			NA

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USEPA
OMC Plant 2, Waukegan, Illinois

Injection WELLS - Area 4 | Time: 1250 | Date: 1/8/2008 | Substrate: Lactate

Well ID and zone / Parameter	Flow meter not operating	IP-# 412 deep	IP-# 416 deep	IP-# 414 deep	IP-# 406 deep	Flow meter not working		IP-# 404 shallow
Wellhead Pressure (psi)		NM	NM	NM	NM			NM
Gate Valve Open (Y/N)		Y	Y	Y	Y			Y
Flow Rate (gpm)		10.43	9.99	9.68	12.32			0
Total Volume into well (gallons)		457	503	512	487			301
Injection Start Time		NA	NA	NA	NA			NA
Injection End Time		NA	NA	NA	NA			1251

Injection WELLS - Area 4 | Time: 1255 | Date: 1/8/2008 | Substrate: Lactate

Well ID and zone / Parameter	Flow meter not operating	IP-# 412 deep	IP-# 416 deep	IP-# 414 deep	IP-# 406 deep	Flow meter not working		IP-# 404 shallow
Wellhead Pressure (psi)		NM	NM	NM	NM			
Gate Valve Open (Y/N)		Y	Y	Y	Y			
Flow Rate (gpm)		13.14	12.21	12.04	14.81			
Total Volume into well (gallons)		554	554	554	554			
Injection Start Time		NA	NA	NA	NA			
Injection End Time		0:00	1256	1256	1257			

Injection WELLS - Area 4 | Time: 1330 | Date: 1/8/2008 | Substrate: Lactate

Well ID and zone / Parameter	IP-# 403 shallow	IP-# 417 deep	IP-# 413 deep	IP-# 411 deep	IP-# 410 deep	Flow meter not working		IP-# 408 deep
Wellhead Pressure (psi)	1	7	2	2	8			8
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	7.46	10.35	11.24	11.91	10.93			13.61
Total Volume into well (gallons)	90	72	110	106	82			85
Injection Start Time	13:21	13:21	13:21	13:21	13:21			13:21
Injection End Time	NA	NA	NA	NA	NA			NA

Injection WELLS - Area 4 | Time: 1345 | Date: 1/8/2008 | Substrate: Lactate

Well ID and zone / Parameter	IP-# 403 shallow	IP-# 417 deep	IP-# 413 deep	IP-# 411 deep	IP-# 410 deep	Flow meter not working		IP-# 408 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	NM			NM
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	7.59	10.63	11.27	11.29	14.12			13.38
Total Volume into well (gallons)	201	229	279	277	264			286
Injection Start Time	NA	NA	NA	NA	NA			NA
Injection End Time	NA	NA	NA	NA	NA			NA

Injection WELLS - Area 4 | Time: 1400 | Date: 1/8/2008 | Substrate: Lactate

Well ID and zone / Parameter	IP-# 403 shallow	IP-# 417 deep	IP-# 413 deep	IP-# 411 deep	IP-# 410 deep	Flow meter not working		IP-# 408 deep
Wellhead Pressure (psi)	1	7	3	3	8			8
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	7.58	10.65	11.30	11.30	4.46			13.67
Total Volume into well (gallons)	335	415	475	473	480			515
Injection Start Time	NA	NA	NA	NA	NA			NA
Injection End Time	NA	NA	NA	NA	NA			NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

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Injection WELLS - Area 4 Time: 1410 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	IP-# 403 shallow	IP-# 417 deep	IP-# 413 deep	IP-# 411 deep	IP-# 410 deep	Flow meter not working		IP-# 408 deep
Wellhead Pressure (psi)	NA	NA	NA	NA	NA			NA
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	0.00	0.00	0.00	0.00	0.00			0.00
Total Volume into well (gallons)	399	554	554	554	554			554
Injection Start Time	NA	NA	NA	NA	NA			NA
Injection End Time	14:12	14:14	14:11	14:11	14:08			1405

Injection WELLS - Area 4 Time: 1440 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-# 418 deep	IP-# 402 shallow	IP-# 400 shallow	IP-# 415 deep	Flow meter not working		IP-# 405 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	NM			NM
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	9.57	11.57	12.56	10.17	10.68			9.01
Total Volume into well (gallons)	106	42	145	131	46			54
Injection Start Time	14:40	14:40	14:40	14:40	14:40			14:40
Injection End Time	NA	NA	NA	NA	NA			NA

Injection WELLS - Area 4 Time: 1455 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-# 418 deep	IP-# 402 shallow	IP-# 400 shallow	IP-# 415 deep	Flow meter not working		IP-# 405 deep
Wellhead Pressure (psi)	5	5	0	4	9			8
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	11.2	13.98	12.67	11.94	15.18			15
Total Volume into well (gallons)	208	144	257	236	170			172
Injection Start Time	NA	NA	NA	NA	NA			NA
Injection End Time	NA	NA	NA	NA	NA			NA

Injection WELLS - Area 4 Time: 1505 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-# 418 deep	IP-# 402 shallow	IP-# 400 shallow	IP-# 415 deep	Flow meter not working		IP-# 405 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	NM			NM
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	11.4	9.66	10.25	6.47	17.57			15.23
Total Volume into well (gallons)	314	285	375	345	321			320
Injection Start Time	NA	NA	NA	NA	NA			NA
Injection End Time	NA	NA	NA	NA	NA			NA

Sodium Lactate Injection Pilot Study System Performance Data Collection Form

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Injection WELLS - Area 4 Time: 1512 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-# 418 deep	IP-# 402 shallow	IP-# 400 shallow	IP-# 415 deep	Flow meter not working		IP-# 405 deep
Wellhead Pressure (psi)	NM	NM	NM	NM	NM			NM
Gate Valve Open (Y/N)	Y	Y	Y	Y	Y			Y
Flow Rate (gpm)	16.17	15.49	0	0	14.78			13.1
Total Volume into well (gallons)	376	354	399	399	399			389
Injection Start Time	NA	NA	NA	NA	NA			NA
Injection End Time	NA	NA	15:08	15:10	NA			NA

Injection WELLS - Area 4 Time: 1520 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	IP-# 409 deep	IP-# 418 deep	IP-# 402 shallow	IP-# 400 shallow	IP-# 415 deep	Flow meter not working		IP-# 405 deep
Wellhead Pressure (psi)	NM	NM			NM			NM
Gate Valve Open (Y/N)	Y	Y			Y			Y
Flow Rate (gpm)	0	0			0			0
Total Volume into well (gallons)	554	554			554			554
Injection Start Time	NA	NA			NA			NA
Injection End Time	1523	1525			1520			15:25

Injection WELLS - Area 4 Time: 1600 Date: 1/8/2008 Substrate: Lactate

Well ID and zone / Parameter	IP-# 419 deep	IP-# 407 deep	IP-# 401 shallow
Wellhead Pressure (psi)	9	6	4
Gate Valve Open (Y/N)	Y	Y	Y
Flow Rate (gpm)	20.45	16.22	16.93
Total Volume into well (gallons)	52	47	42
Injection Start Time	16:00	16:00	16:00
Injection End Time	NA	NA	NA

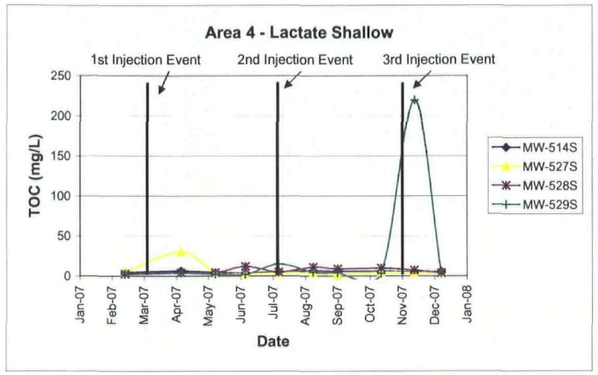
Injection WELLS - Area 4 Time: 1605 Date: 1/8/2008 Substrate: Lactate

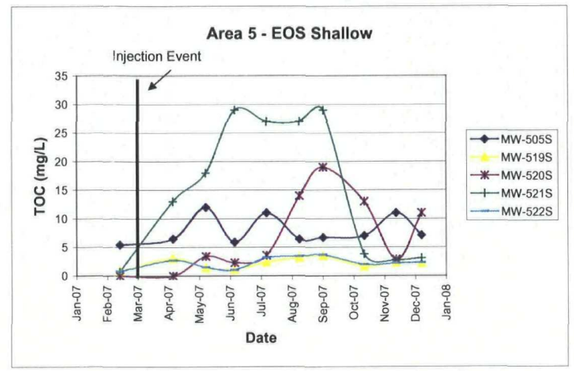
Well ID and zone / Parameter	IP-# 419 deep	IP-# 407 deep	IP-# 401 shallow
Wellhead Pressure (psi)	NM	NM	NM
Gate Valve Open (Y/N)	Y	Y	Y
Flow Rate (gpm)	0	0	0
Total Volume into well (gallons)	110	110	80
Injection Start Time	NA	NA	NA
Injection End Time	16:10	16:10	16:10

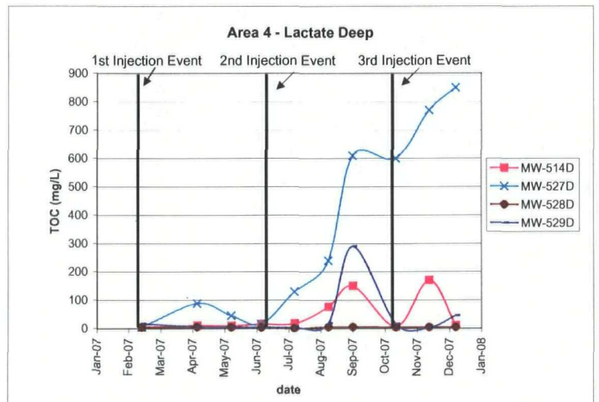
Appendix B
Data Summary Tables and Plots

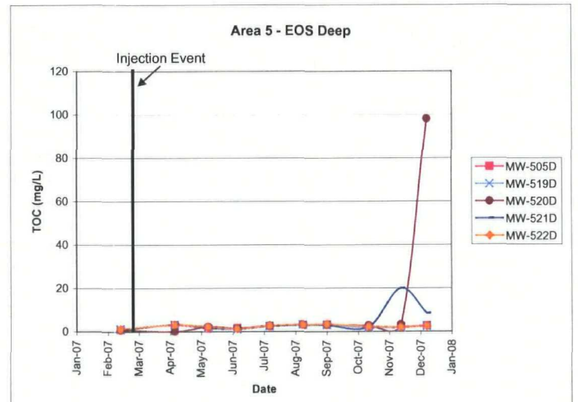
TOC (mg/L)

Area 4	Baseline 19-Feb-07	secondary 12-Apr-07	secondary 14-May-07	primary 11-Jun-07	secondary 12-Jul-07	secondary 13-Aug-07	primary 5-Sep-07	secondary 15-Oct-07	secondary 15-Nov-07	primary 10-Dec-07
MW-514S	4	6.4	5	3.5	5.2	6.3	5.8	5.6	5.2	5.3
MW-514D	5	11	10	16	18	77	150	5.9	170	11
MW-527S	5	30	5	2.8	3.8	3.9	1	4.8	4.1	4.4
MW-527D	6	89	46	16	130	240	610	600	770	850
MW-528S	3	4.4	4	12	4.8	11	8.9	9.8	7.4	3.9
MW-528D	4	5.5	4	3.3	5.6 J	5.5	5.4	4.1	4.2	4.2
MW-529S	2	3.9	3	1.9	15	4.7	4.1	3.2	220	3.5
MW-529D	18	6.5	5	4.2	4.9	19	290	15	2.9	46
Area 5										
MW-505S	5.4	6.5	12	5.9	11	6.4	6.7	7	11	7.1
MW-505D	0.93	3	1	1.6	2.5	3.1	3.2	2	2.1	2.7
MW-519S	0.85	3	1	1.1	2.4	3.2	3.5	1.7	2.3	2.2
MW-519D	1.3	3.3	2	1	2.5	3.3	3	1.8	1.8	2.5
MW-520S	NS	NS	3	2.3	3.6	14	19	13	2.9	11
MW-520D	0.83	NS	2	1.5	2.7	3.2	3.1	2.8	3.3	98
MW-521S	0.7	13	18	29	27	27	29	3.8	2.8	3.1
MW-521D	0.7	3.3	2	1.4	2.5	2.9	2.9	2.1	20	8.4
MW-522S	0.81	2.7	2	1	3.2	3.4	3.7	2	2.2	2.3
MW-522D	1.2	3.1	2	1.3	2.7	3.1	3.4	2.3	2	2.5



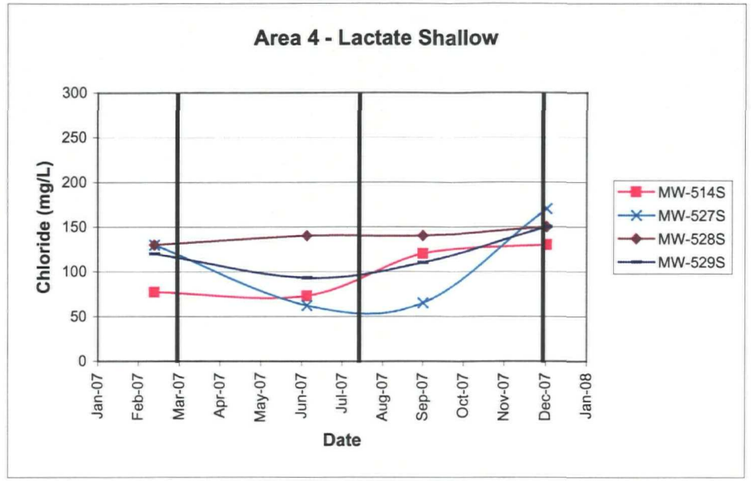


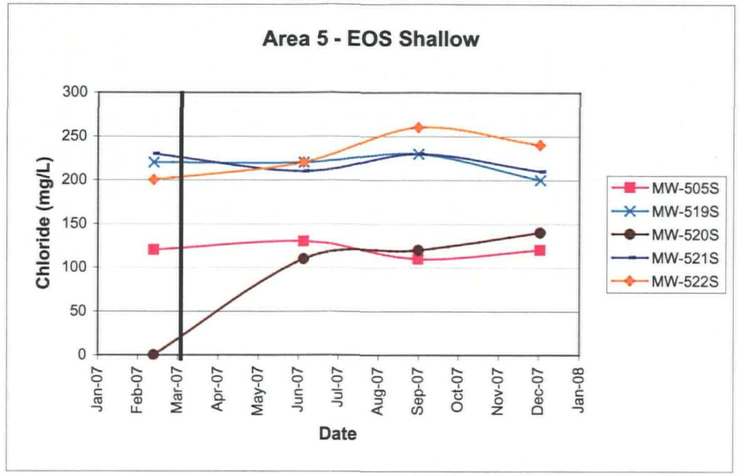


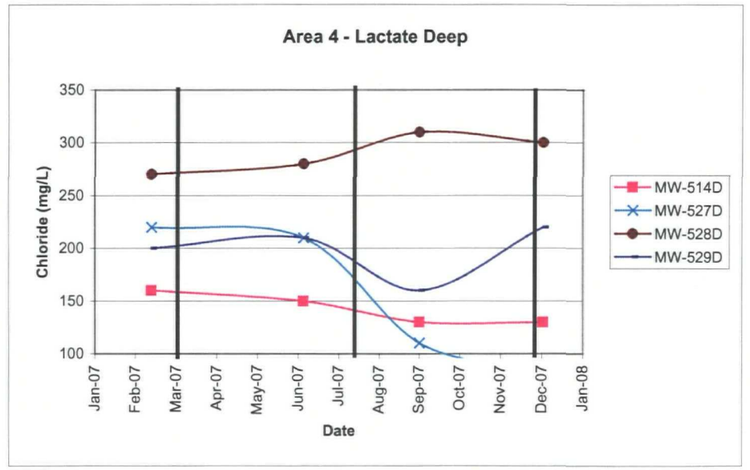


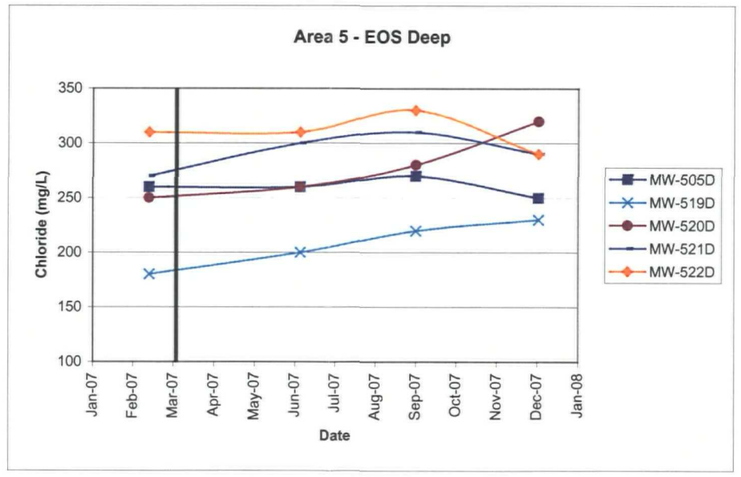
Cloride (mg/L)

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	77	73	120	130
MW-514D	160	150	130	130
MW-527S	130	62	65	170
MW-527D	220	210	110	84
MW-528S	130	140	140	150
MW-528D	270	280	310	300
MW-529S	120	93	110	150
MW-529D	200	210	160	220
Area 5				
MW-505S	120	130	110	120
MW-505D	260	260	270	250
MW-519S	220	220	230	200
MW-519D	180	200	220	230
MW-520S	NS	110	120	140
MW-520D	250	260	280	320
MW-521S	230	210	230	210
MW-521D	270	300	310	290
MW-522S	200	220	260	240
MW-522D	310	310	330	290



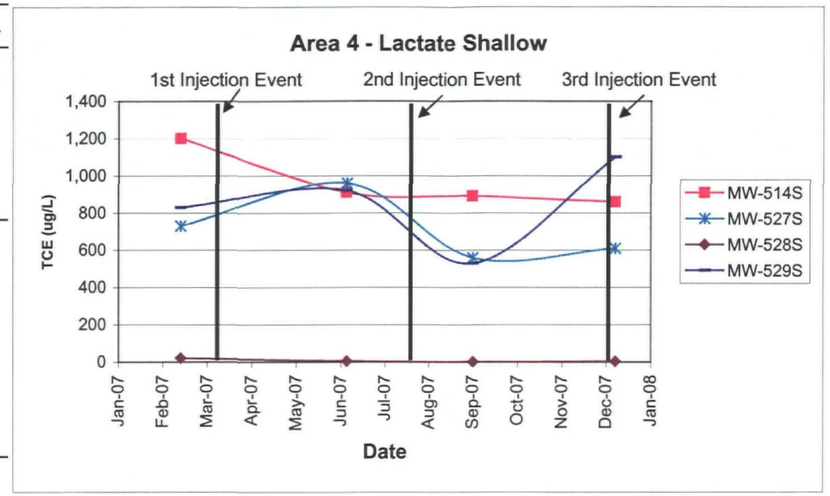


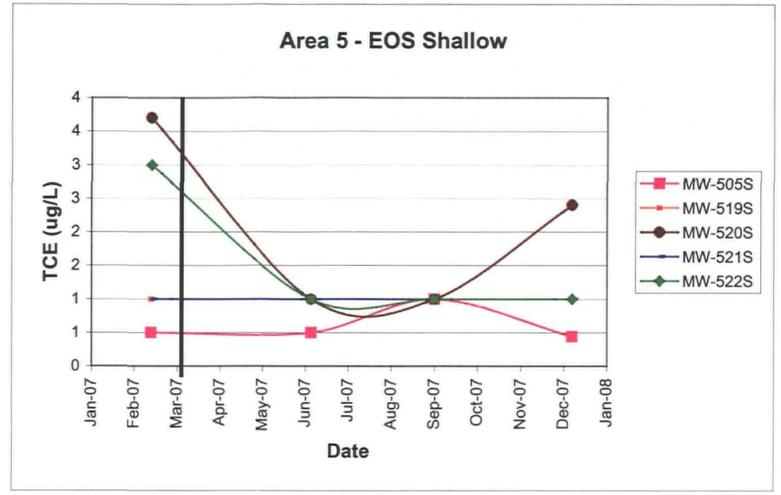


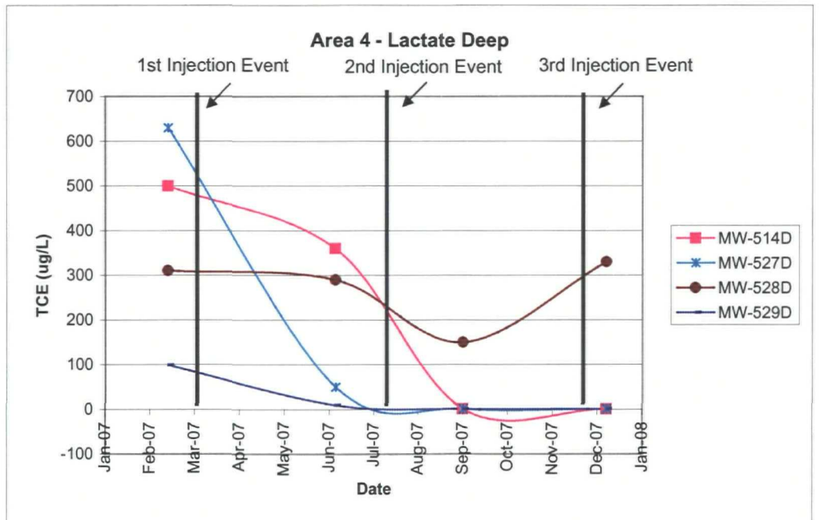


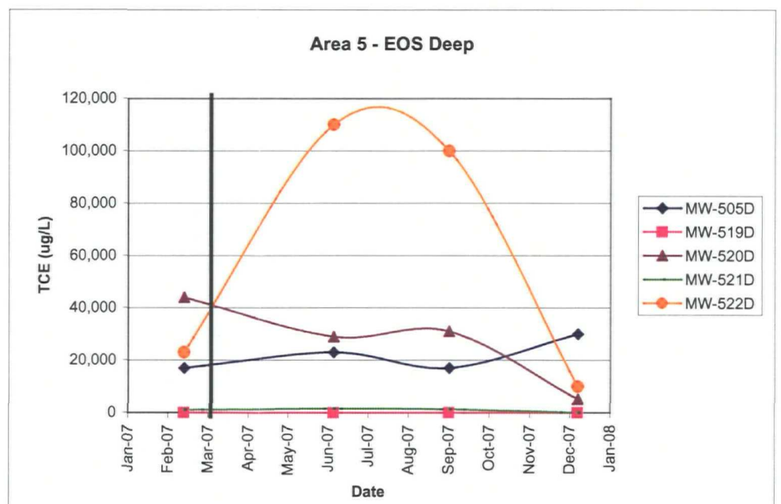
TCE (µg/L)

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 10-Dec-07
MW-514S	1,200	910	890	860
MW-514D	500	360	1	1
MW-527S	730	960	560	610
MW-527D	630	50	1	1
MW-528S	22	5	1	4
MW-528D	310	290	150	330
MW-529S	830	920	530	1,100
MW-529D	99	9	1	1
Area 5				
MW-505S	1	1	1	0
MW-505D	17,000	23,000	17,000	30,000
MW-519S	1	1	1	1
MW-519D	16	0	1	1
MW-520S	4	1	1	2
MW-520D	44,000	29,000	31,000	5,100
MW-521S	1	1	1	1
MW-521D	1,100	1,500	1,300	1
MW-522S	3	1	1	1
MW-522D	23,000	110,000	100,000	10,000



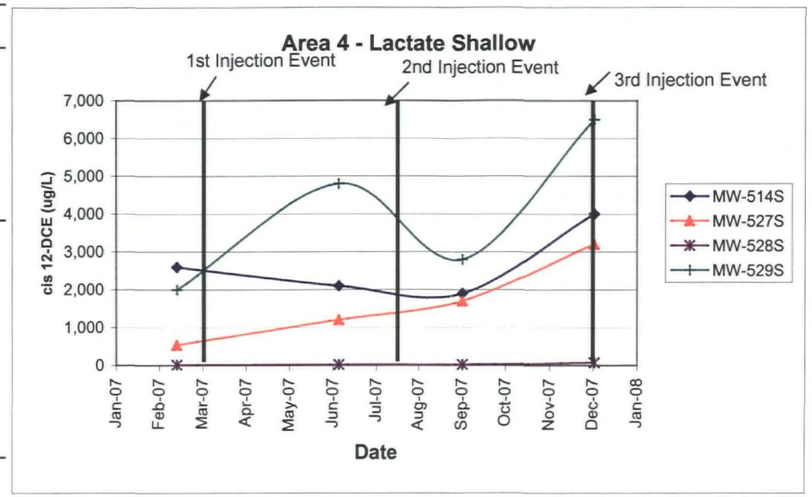


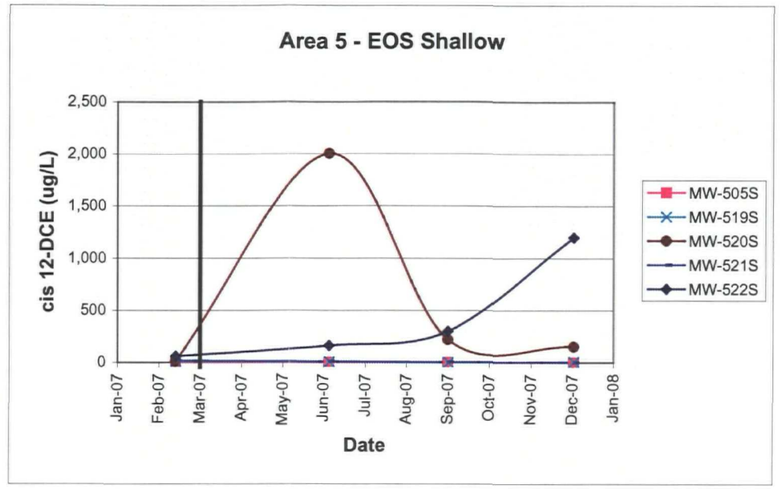


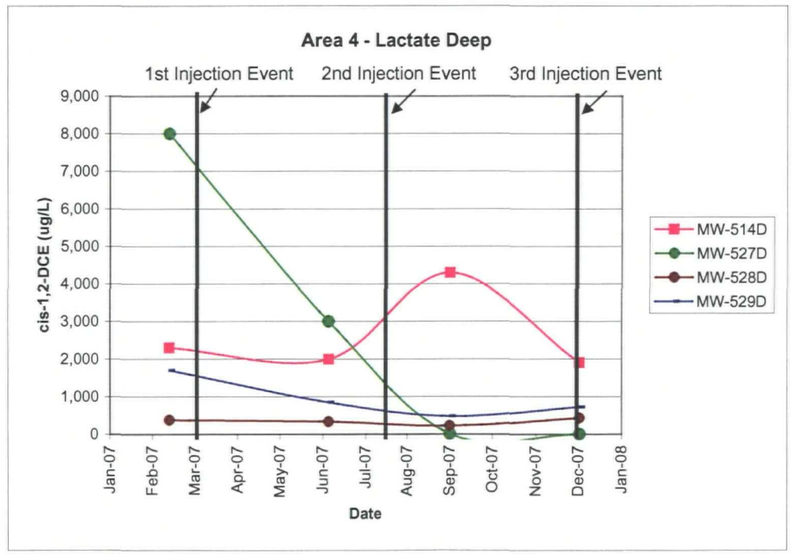


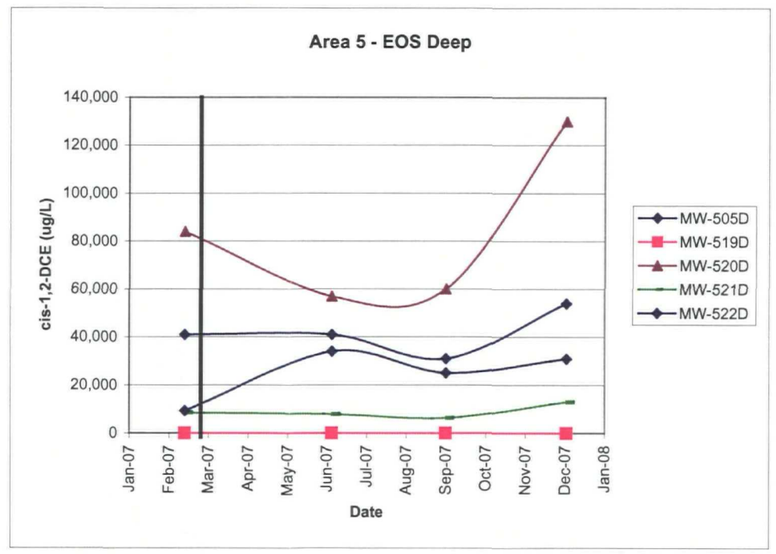
cis-12DCE (µg/L)

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	2,600	2,100	1,900	4,000
MW-514D	2,300	2,000	4,300	1,900
MW-527S	540	1,200	1,700	3,200
MW-527D	8,000	3,000	5	3
MW-528S	12	17	18	73
MW-528D	380	340	220	430
MW-529S	2,000	4,800	2,800	6,500
MW-529D	1,700	850	480	720
Area 5				
MW-505S	1	1	1	0
MW-505D	41,000	41,000	31,000	54,000
MW-519S	8	4	1	7
MW-519D	12	0	1	0
MW-520S	9	2,000	220	150
MW-520D	84,000	57,000	60,000	130,000
MW-521S	16	10	4	0
MW-521D	8,500	7,800	6,300	13,000
MW-522S	58	160	300	1,200
MW-522D	9,300	34,000	25,000	31,000



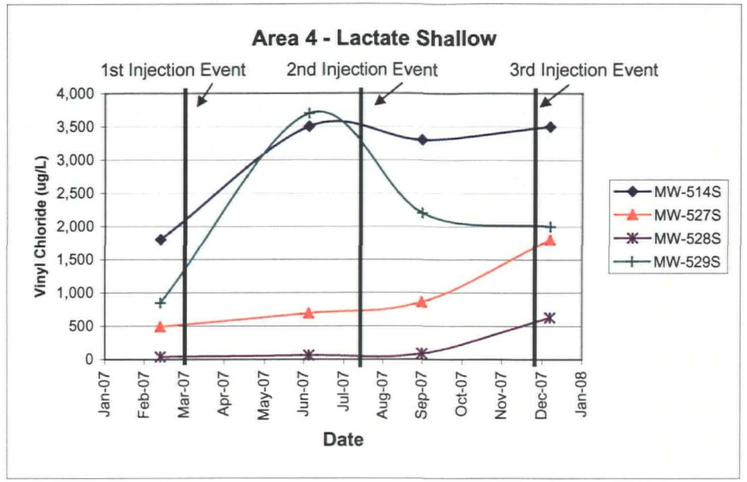


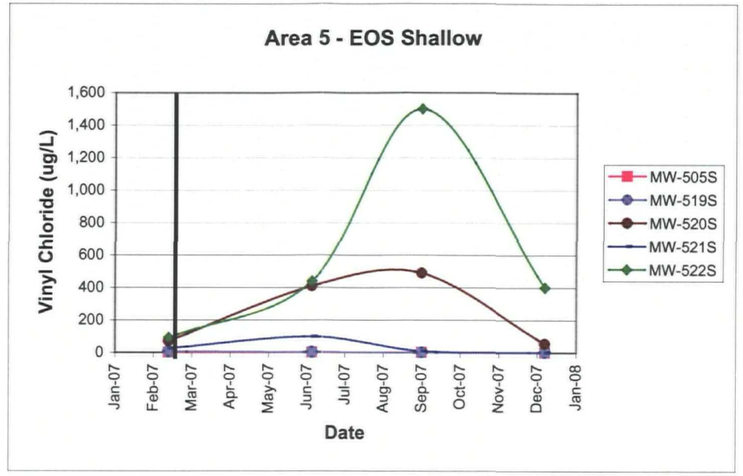


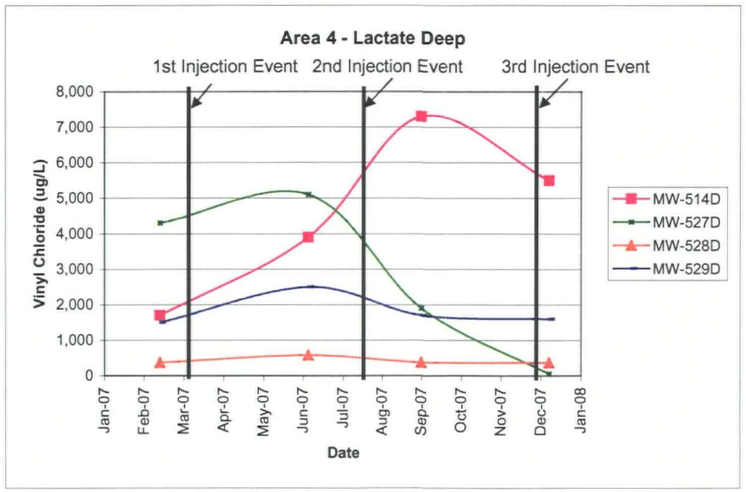


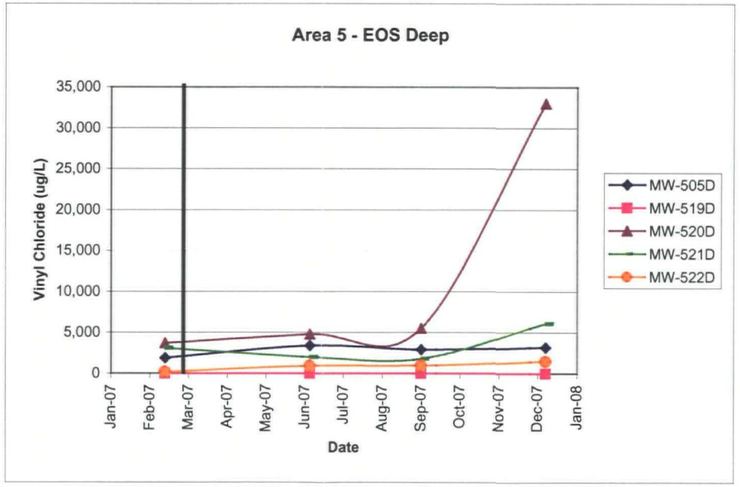
VC (µg/L)

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 10-Dec-07
MW-514S	1,800	3,500	3,300	3,500
MW-514D	1,700	3,900	7,300	5,500
MW-527S	490	690	860	1,800
MW-527D	4,300	5,100	1,900	58
MW-528S	37	63	87	630
MW-528D	370	580	380	370
MW-529S	850	3,700	2,200	2,000
MW-529D	1,500	2,500	1,700	1,600
Area 5				
MW-505S	1	1	1	1
MW-505D	1,900	3,400	2,900	3,200
MW-519S	6	3	1	1
MW-519D	1	0	1	1
MW-520S	71	410	490	55
MW-520D	3,700	4,800	5,500	33,000
MW-521S	26	99	9	1
MW-521D	3,100	2,000	1,800	6,100
MW-522S	92	440	1,500	400
MW-522D	200	930	960	1,500



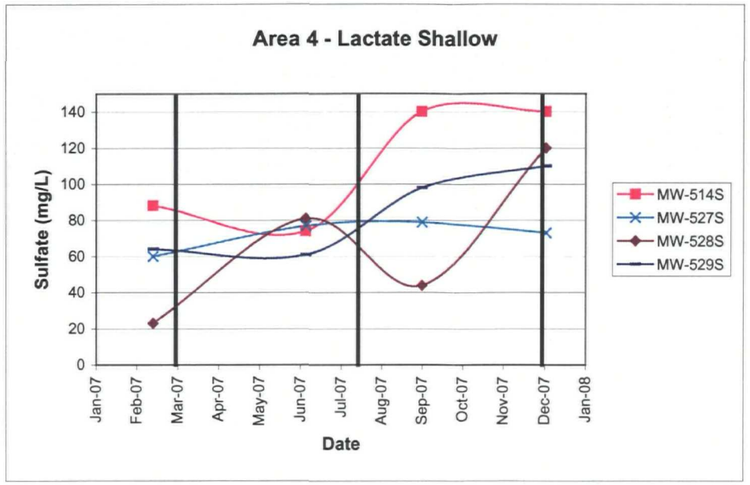


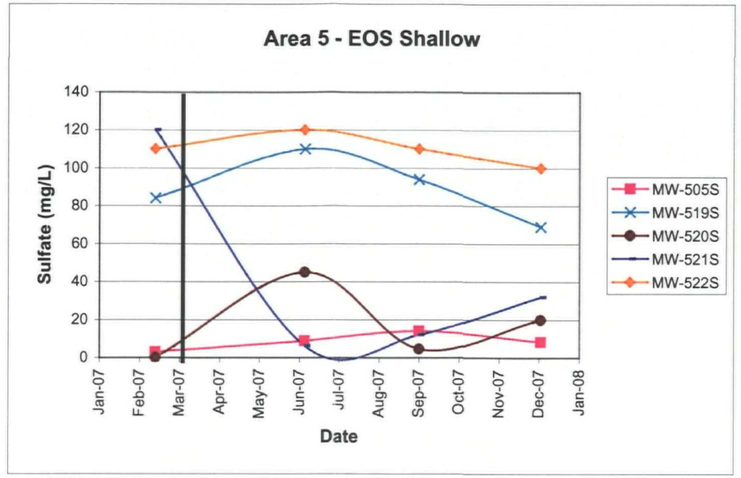


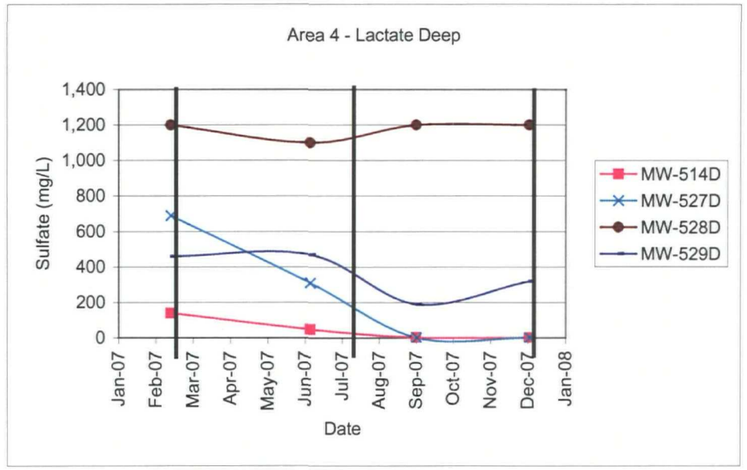


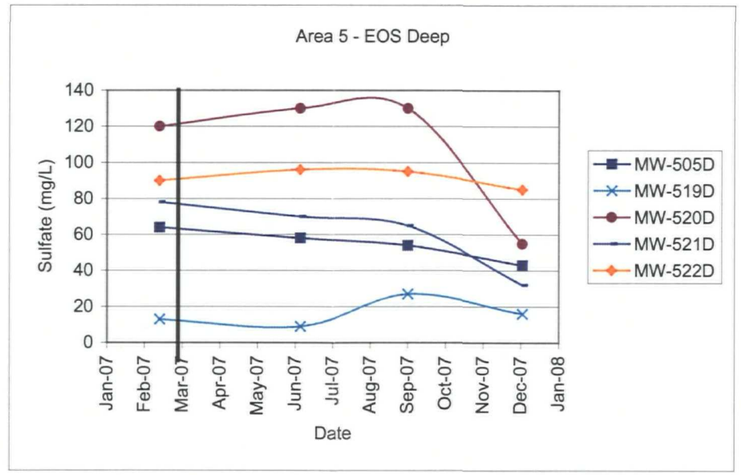
Sulfate (AS SO_4)

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	88	74	140	140
MW-514D	140	48	3	2
MW-527S	60	77	79	73
MW-527D	690	310	1	1
MW-528S	23	81	44	120
MW-528D	1,200	1,100	1,200	1,200
MW-529S	64	61	98	110
MW-529D	460	470	190	320
Area 5				
MW-505S	3	9	14	8
MW-505D	64	58	54	43
MW-519S	84	110	94	69
MW-519D	13	9	27	16
MW-520S	0	45	5	20
MW-520D	120	130	130	55
MW-521S	120	6	12	32
MW-521D	78	70	65	32
MW-522S	110	120	110	100
MW-522D	90	96	95	85



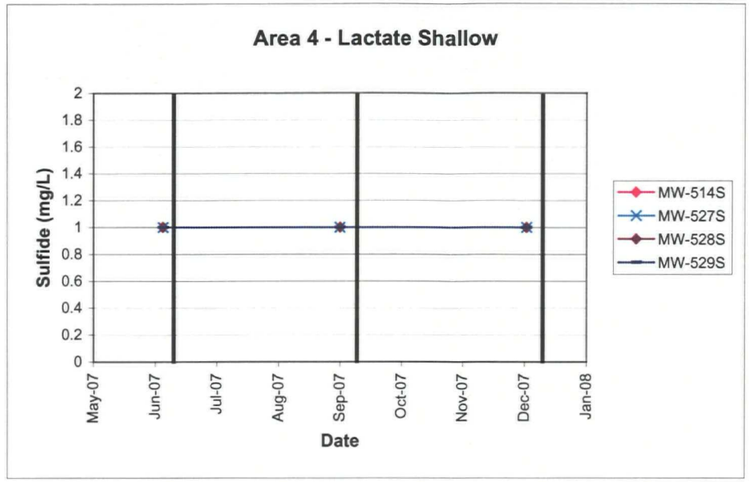


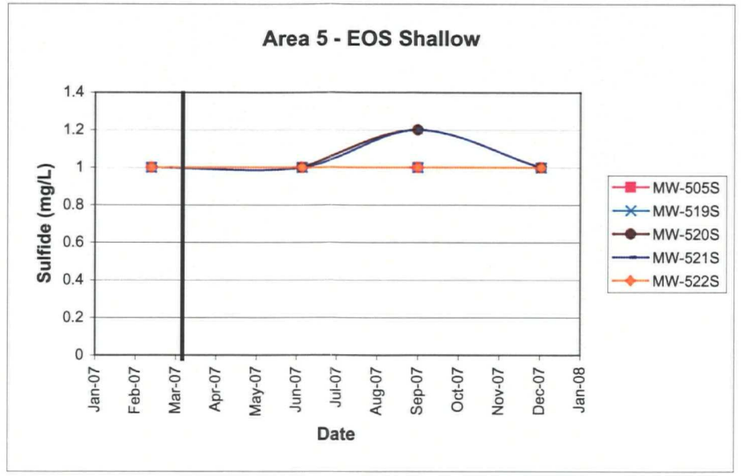


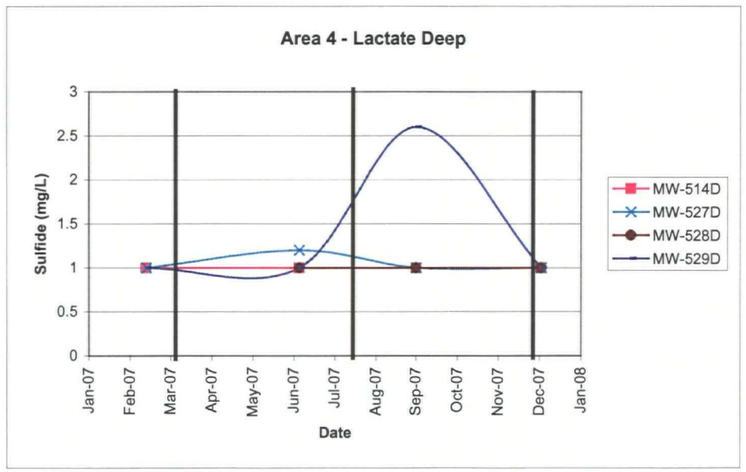


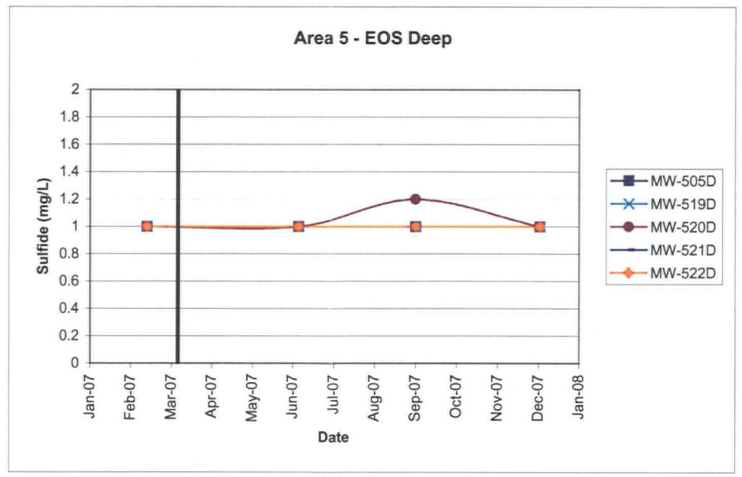
Sulfide

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	1	1	1	1
MW-514D	1	1	1	1
MW-527S	1	1	1	1
MW-527D	1	1.2	1	1
MW-528S	1	1	1	1
MW-528D	1	1	1	1
MW-529S	1	1	1	1
MW-529D	1	1	2.6	1
Area 5				
MW-505S	1	1	1	1
MW-505D	1	1	1	1
MW-519S	1	1	1	1
MW-519D	1	1	1	1
MW-520S	NS	1	1.2	1
MW-520D	1	1	1.2	1
MW-521S	1	1	1.2	1
MW-521D	1	1	1	1
MW-522S	1	1	1	1
MW-522D	1	1	1	1



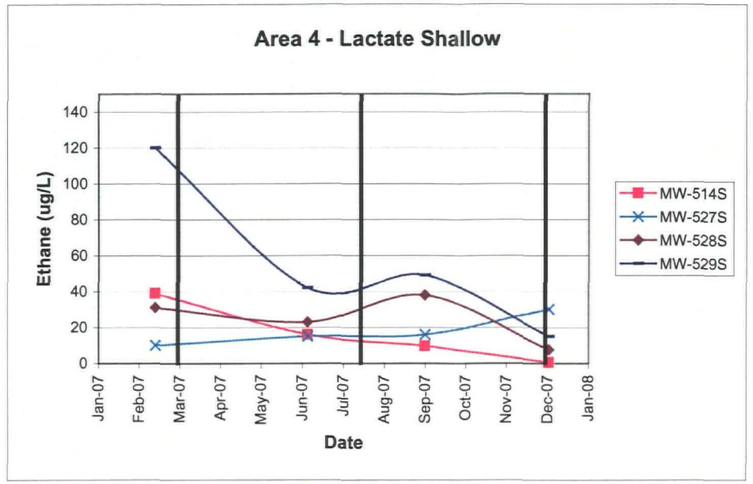


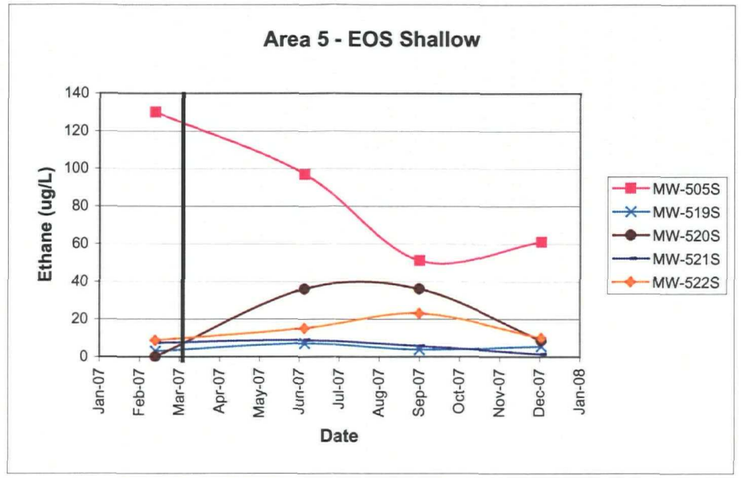


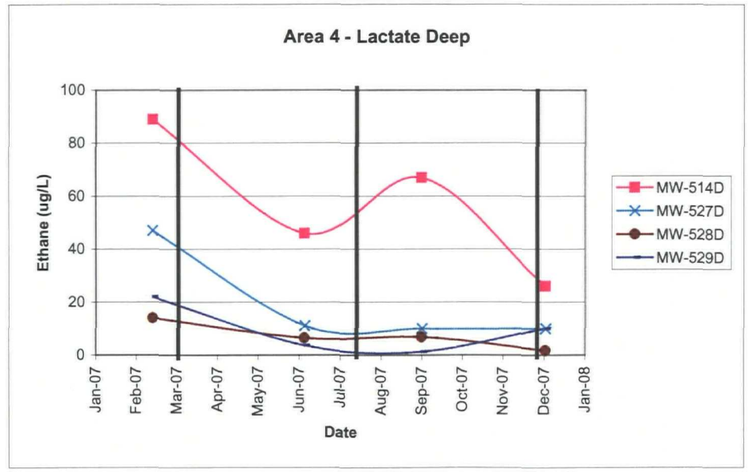


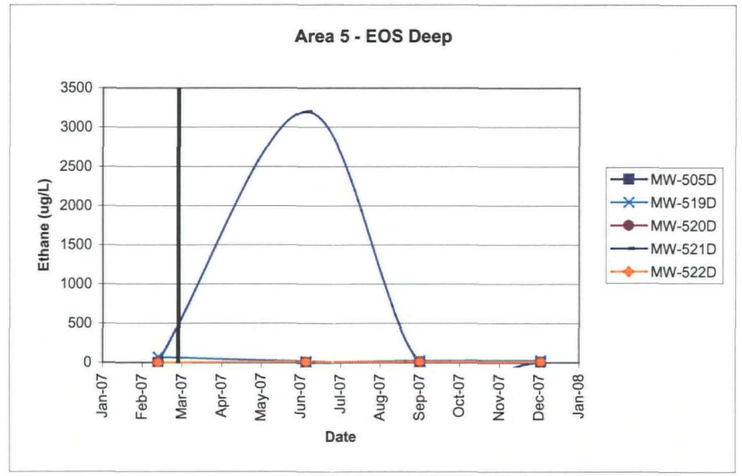
Ethane

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	39	16	9.6	1
MW-514D	89	46	67	26
MW-527S	10	15	16	30
MW-527D	47	11	10	10
MW-528S	31	23	38	8
MW-528D	14	6.4	6.8	2
MW-529S	120	42	49	15
MW-529D	22	3.6	1.2	10
Area 5				
MW-505S	130	97	51	61
MW-505D	1.2	0.93	10	10
MW-519S	3	7.1	3.8	6
MW-519D	69	17	22	27
MW-520S	NS	36	36	9
MW-520D	0.82	10	1.4	1
MW-521S	7.4	8.8	5.7	1
MW-521D	2.7	3200	1.8	1
MW-522S	8.7	15	23	10
MW-522D	0.83	10	10	10



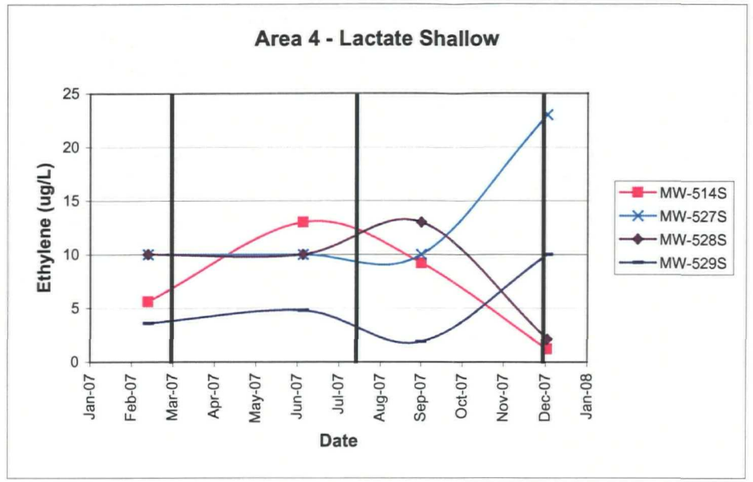


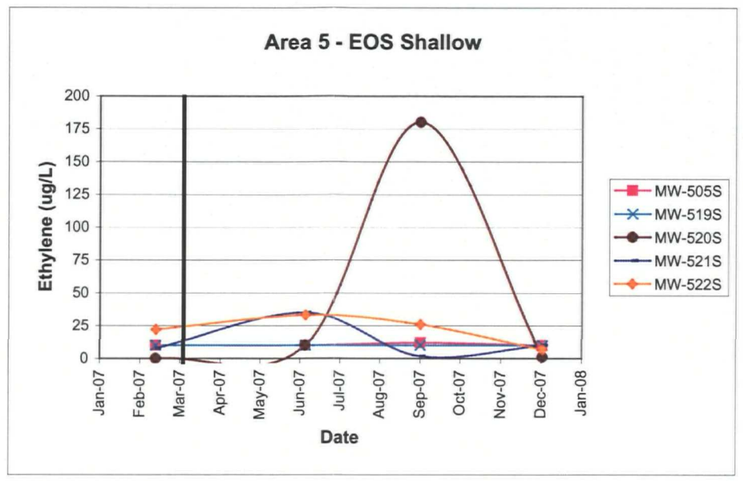


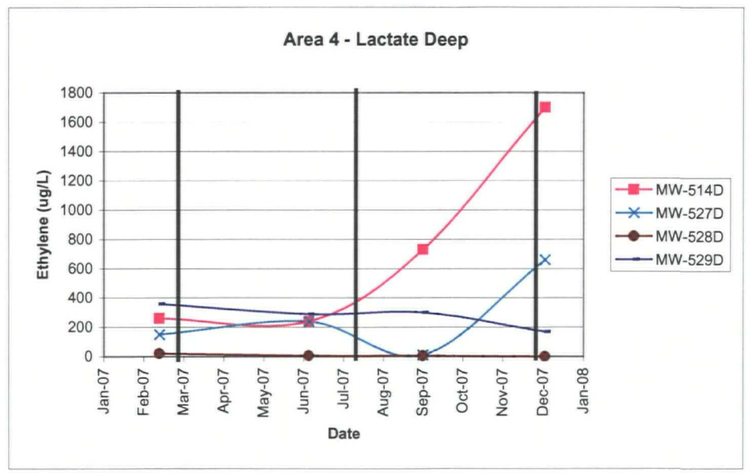


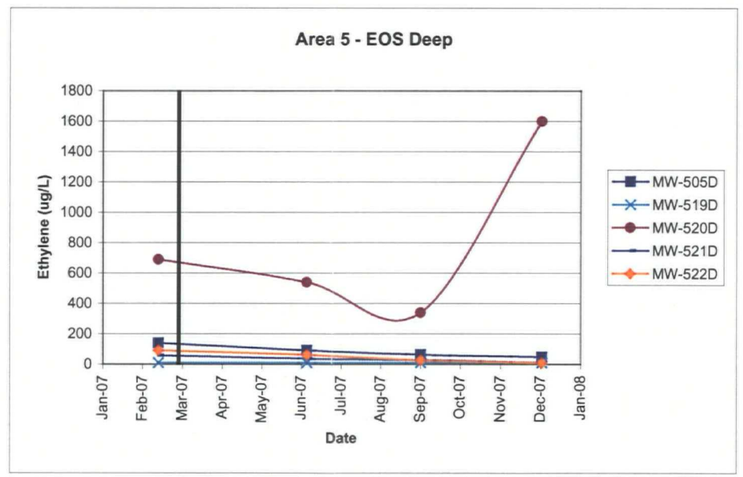
Ethylene

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	5.6	13	9.2	1
MW-514D	260.0	240	730.0	1,700
MW-527S	10.0	10	10.0	23
MW-527D	150.0	240	10.0	660
MW-528S	10.0	10	13.0	2
MW-528D	20.0	7	4.6	1
MW-529S	3.6	5	1.9	10
MW-529D	360.0	290	300.0	170
Area 5				
MW-505S	10.0	10	12.0	10
MW-505D	140.0	92	63.0	48
MW-519S	10.0	10	10.0	10
MW-519D	10.0	10	10.0	10
MW-520S	NS	10	180.0	1
MW-520D	690.0	540	340.0	1,600
MW-521S	7.8	35	1.8	10
MW-521D	59.0	36	29.0	10
MW-522S	22.0	33	26.0	7
MW-522D	91.0	62	26.0	8



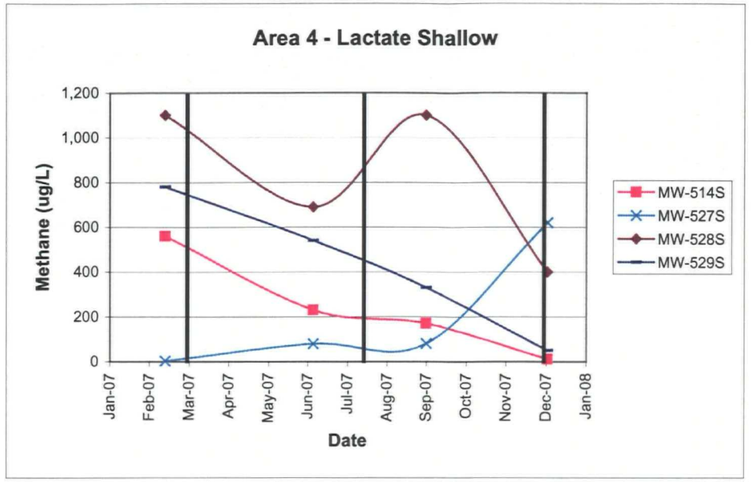


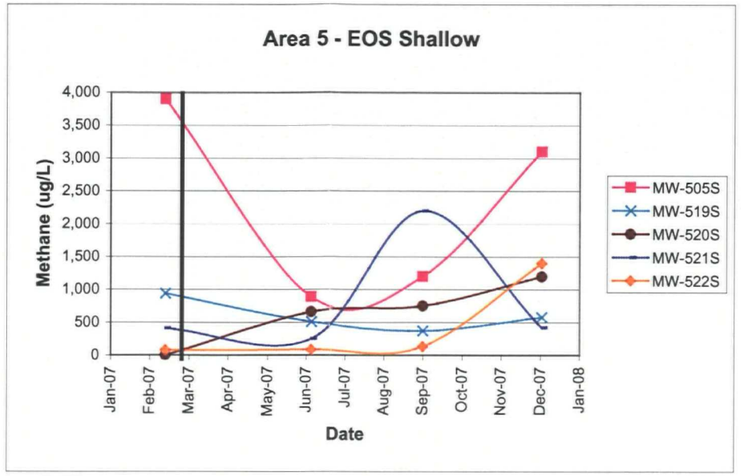


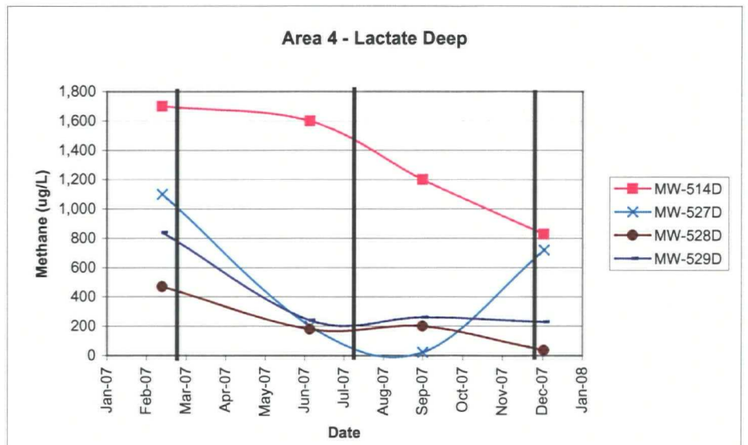


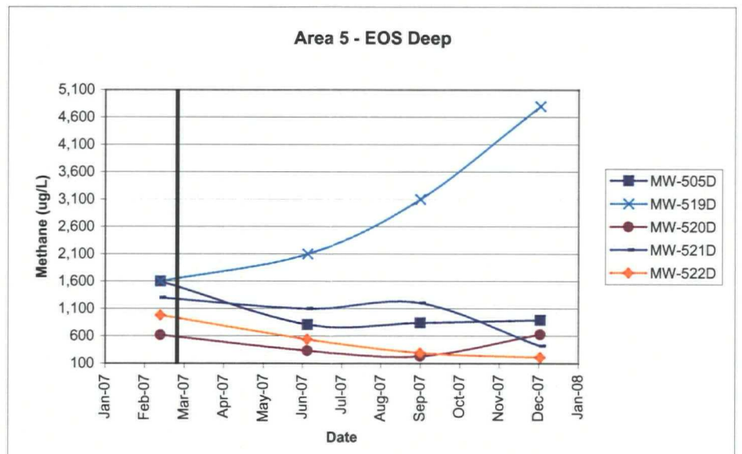
Methane

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	560	230	170	11
MW-514D	1,700	1,600	1,200	830
MW-527S	3	79	80	620
MW-527D	1,100	200	22	720
MW-528S	1,100	690	1,100	400
MW-528D	470	180	200	36
MW-529S	780	540	330	50
MW-529D	840	240	260	230
Area 5				
MW-505S	3,900	890	1,200	3,100
MW-505D	1,600	810	840	890
MW-519S	940	510	370	580
MW-519D	1,600	2,100	3,100	4,800
MW-520S	NS	660	750	1,200
MW-520D	620	330	230	630
MW-521S	410	250	2,200	420
MW-521D	1,300	1,100	1,200	420
MW-522S	76	86	130	1,400
MW-522D	980	540	290	210



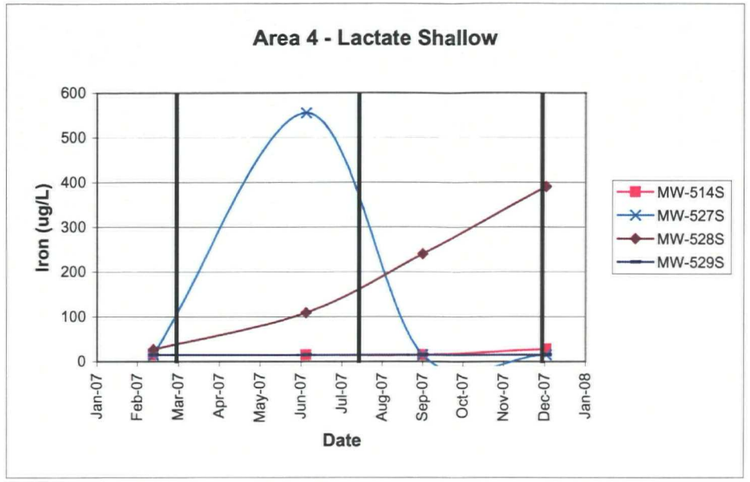


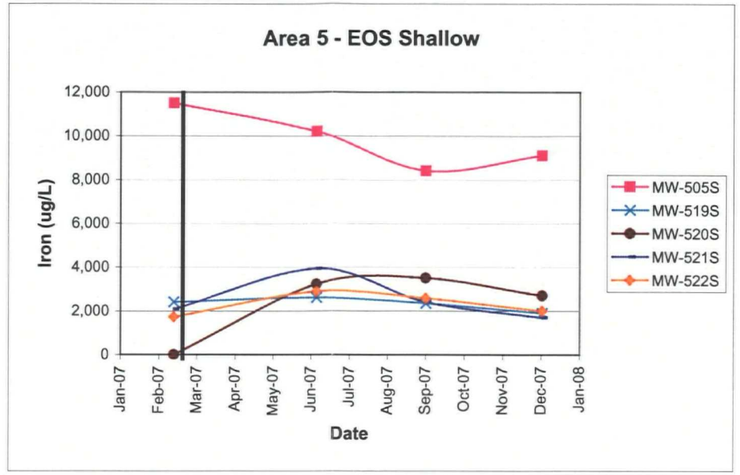


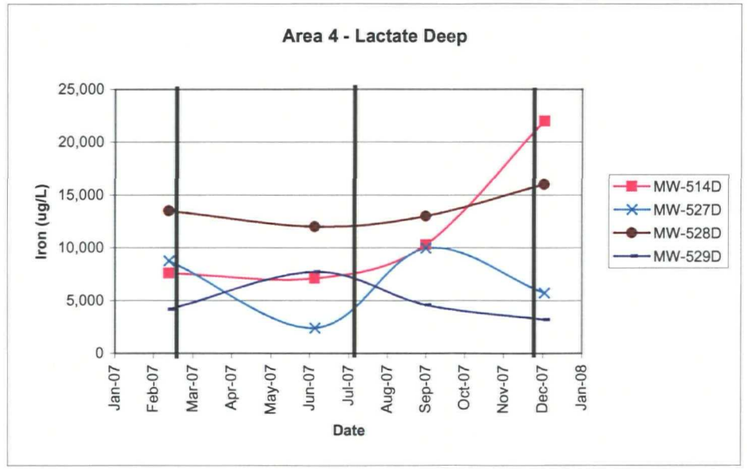


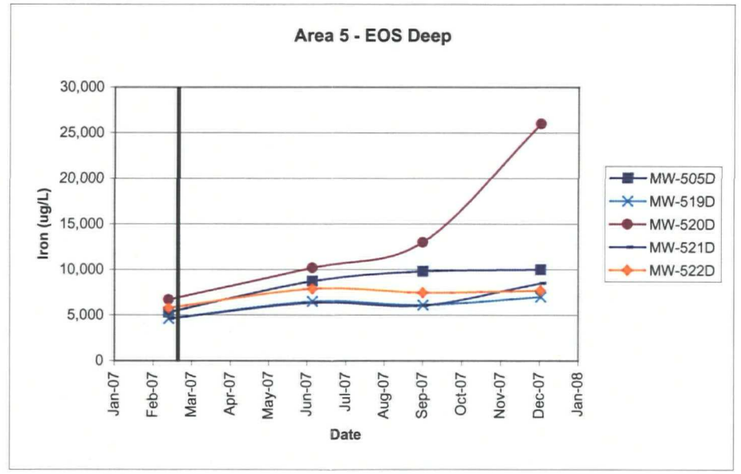
Iron

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	15	15	15	28
MW-514D	7,600	7,100	10,300	22,000
MW-527S	15	555	15	15
MW-527D	8,750	2,390	9,960	5,720
MW-528S	27	109	240	390
MW-528D	13,500	12,000	13,000	16,000
MW-529S	15	15	15	15
MW-529D	4,180	7,720	4,580	3,200
Area 5	0	0	0	
MW-505S	11,500	10,200	8,400	9,100
MW-505D	5,300	8,720	9,800	10,000
MW-519S	2,410	2,610	2,340	1,900
MW-519D	4,600	6,510	6,100	7,000
MW-520S	NS	3,230	3,500	2,700
MW-520D	6,690	10,200	13,000	26,000
MW-521S	2,090	3,940	2,400	1,700
MW-521D	4,620	6,360	6,060	8,500
MW-522S	1,730	2,890	2,580	2,000
MW-522D	5,780	7,900	7,460	7,700



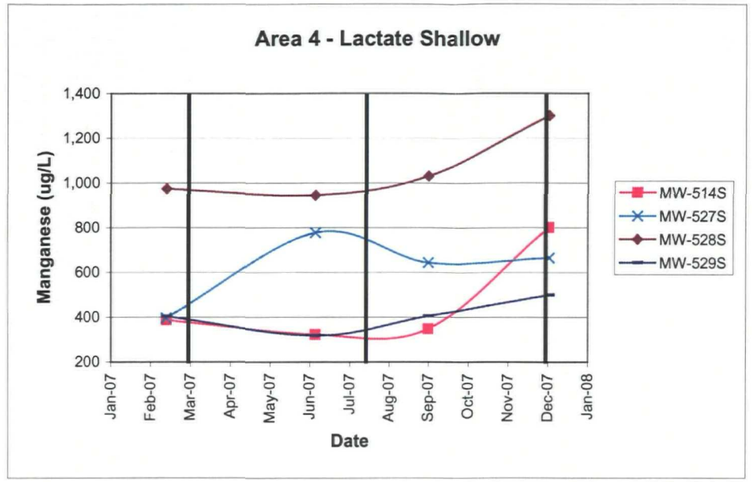


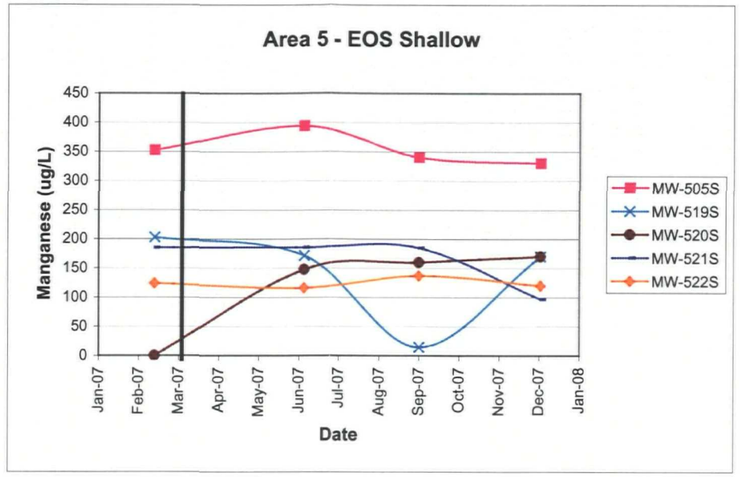


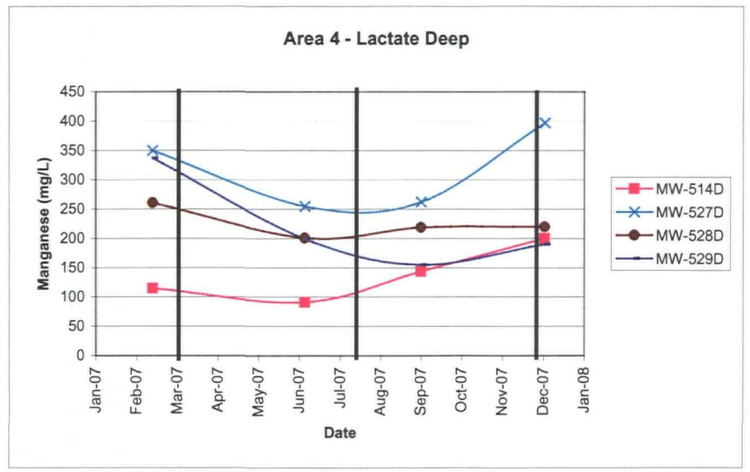


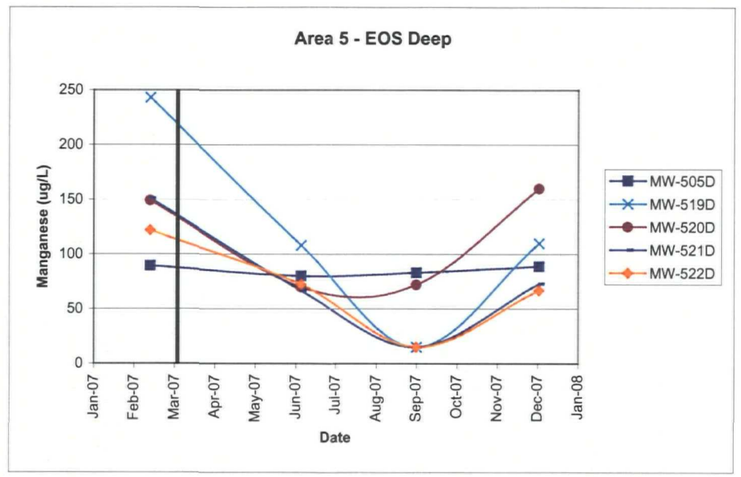
Manganese

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	387	322	348	800
MW-514D	115	91	144	200
MW-527S	396	777	644	665
MW-527D	350	255	262	397
MW-528S	974	944	1,030	1,300
MW-528D	261	201	219	220
MW-529S	404	318	405	500
MW-529D	337	199	155	190
Area 5				
MW-505S	352	394	340	330
MW-505D	89	80	83	89
MW-519S	203	172	15	170
MW-519D	243	108	15	110
MW-520S	NS	148	160	170
MW-520D	149	70	72	160
MW-521S	185	186	185	97
MW-521D	151	67	15	73
MW-522S	124	116	137	120
MW-522D	122	72	15	67



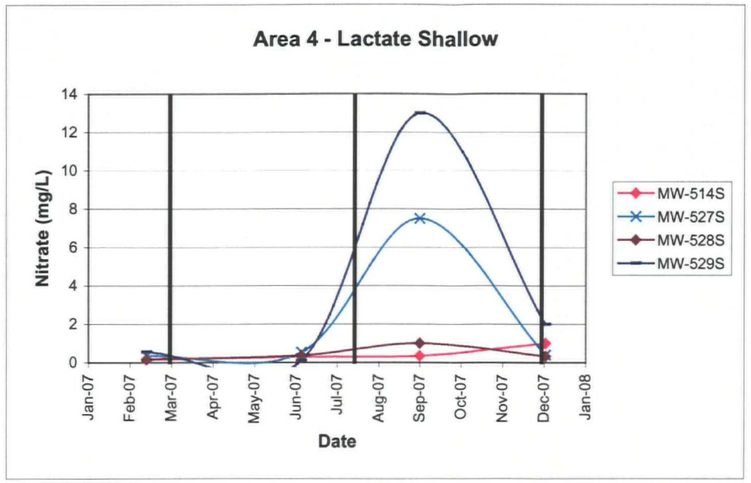


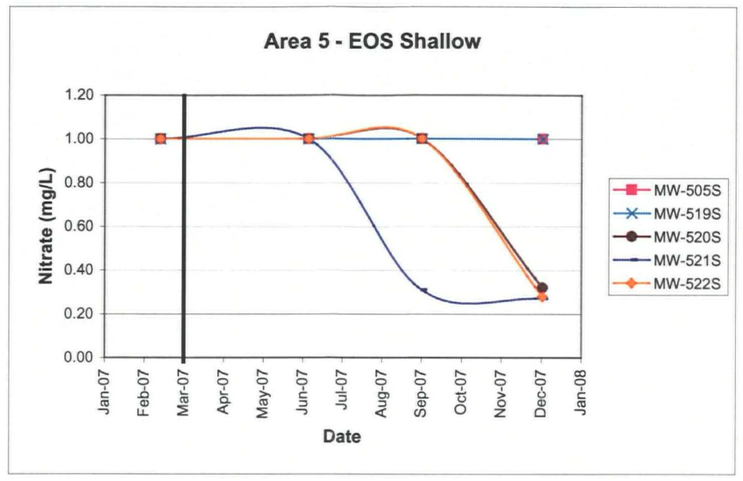


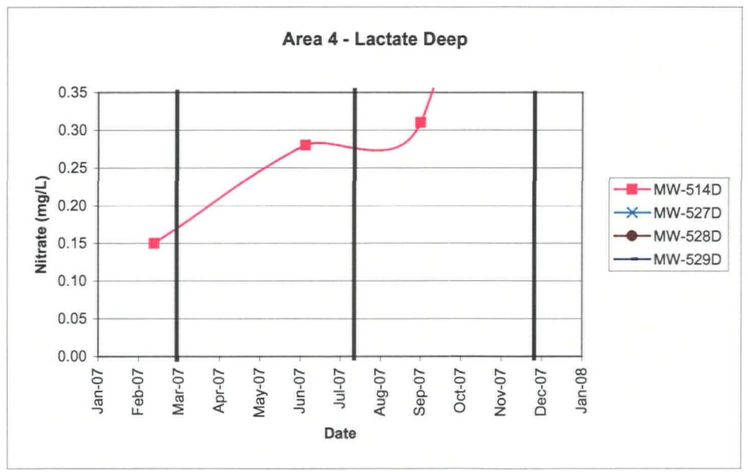


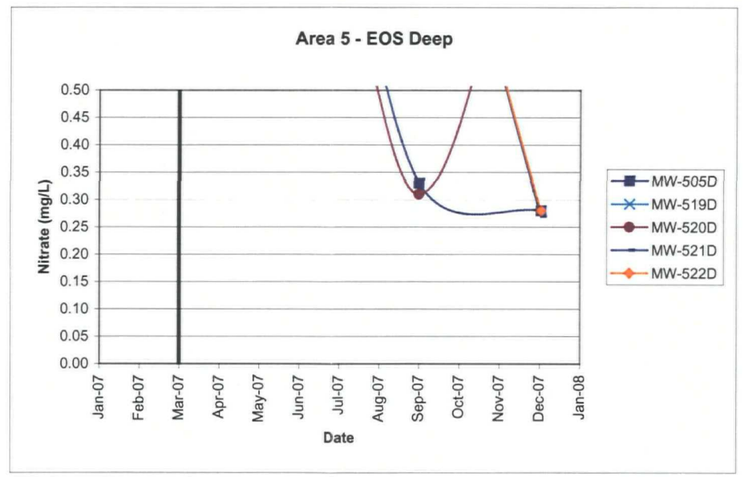
Nitrate (AS N)

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	0.15	0.29	0.35	1
MW-514D	0.15	0.28	0.31	1
MW-527S	0.35	0.53	7.50	0
MW-527D	1.00	1.00	1.00	1
MW-528S	0.17	0.37	1.00	0
MW-528D	1.00	1.00	1.00	1
MW-529S	0.55	0.11	13.00	2
MW-529D	1.00	1.00	1.00	1
Area 5				
MW-505S	1.00	1.00	1.00	1
MW-505D	1.00	1.00	0.33	0
MW-519S	1.00	1.00	1.00	1
MW-519D	1.00	1.00	1.00	1
MW-520S	1.00	1.00	1.00	0
MW-520D	1.00	1.00	0.31	1
MW-521S	1.00	1.00	0.31	0
MW-521D	1.00	1.00	1.00	0
MW-522S	1.00	1.00	1.00	0
MW-522D	1.00	1.00	1.00	0



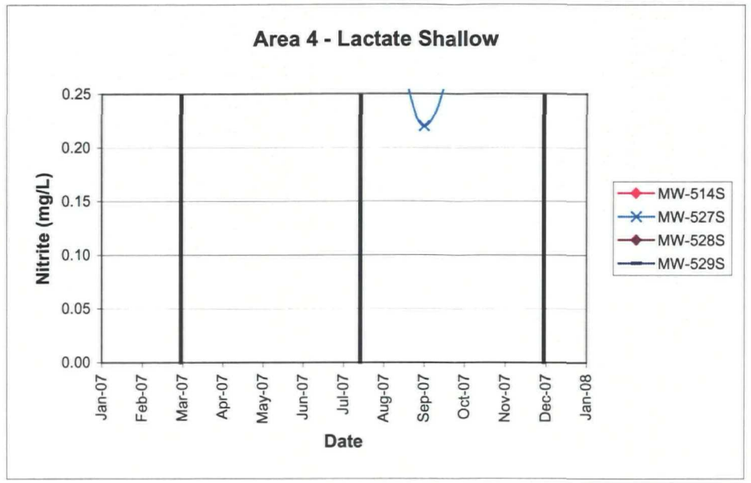


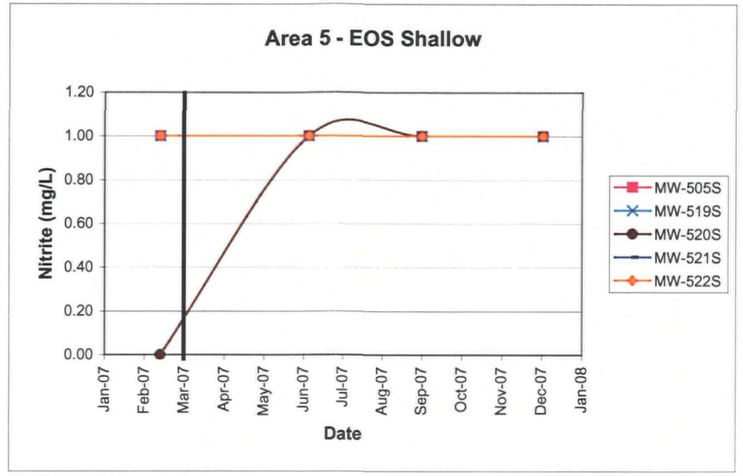


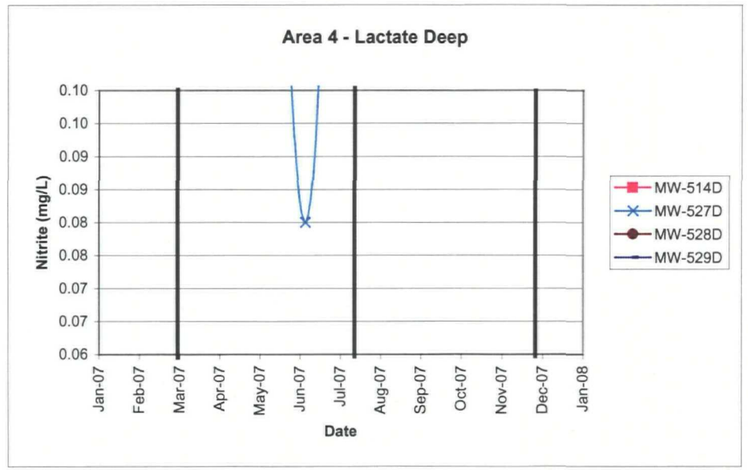


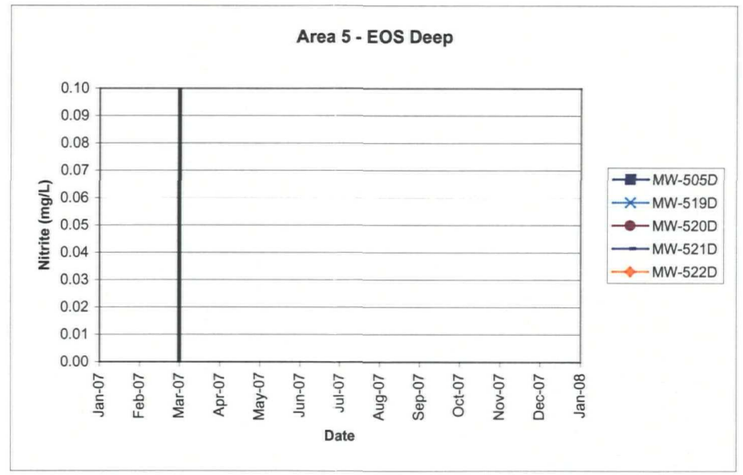
Nitrite

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	1.00	1.00	1.00	1
MW-514D	1.00	1.00	1.00	1
MW-527S	1.00	1.00	0.22	1
MW-527D	1.00	0.08	1.00	1
MW-528S	1.00	1.00	1.00	1
MW-528D	1.00	1.00	1.00	1
MW-529S	1.00	1.00	1.00	1
MW-529D	1.00	1.00	1.00	1
Area 5				
MW-505S	1.00	1.00	1.00	1
MW-505D	1.00	1.00	1.00	1
MW-519S	1.00	1.00	1.00	1
MW-519D	1.00	1.00	1.00	1
MW-520S	NS	1.00	1.00	1
MW-520D	1.00	1.00	1.00	1
MW-521S	1.00	1.00	1.00	1
MW-521D	1.00	1.00	1.00	1
MW-522S	1.00	1.00	1.00	1
MW-522D	1.00	1.00	1.00	1



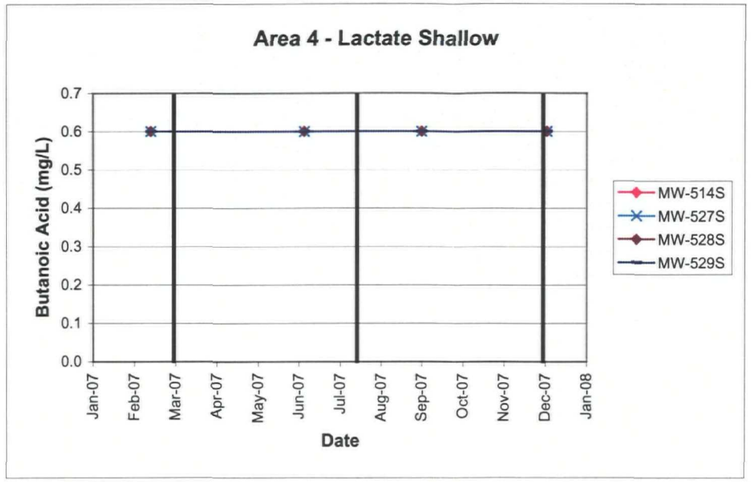


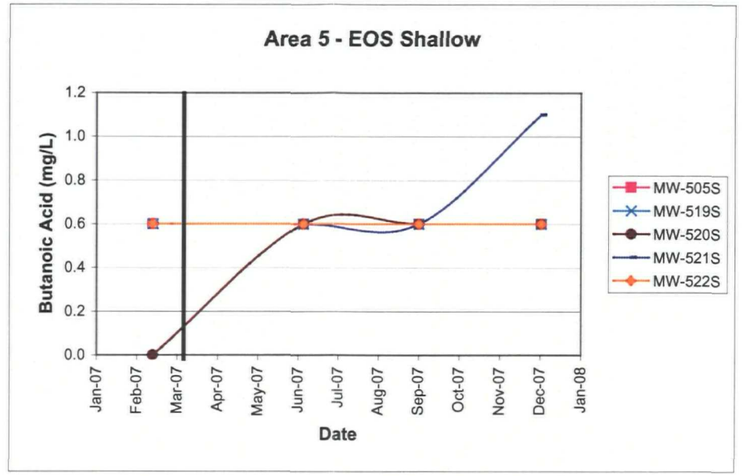


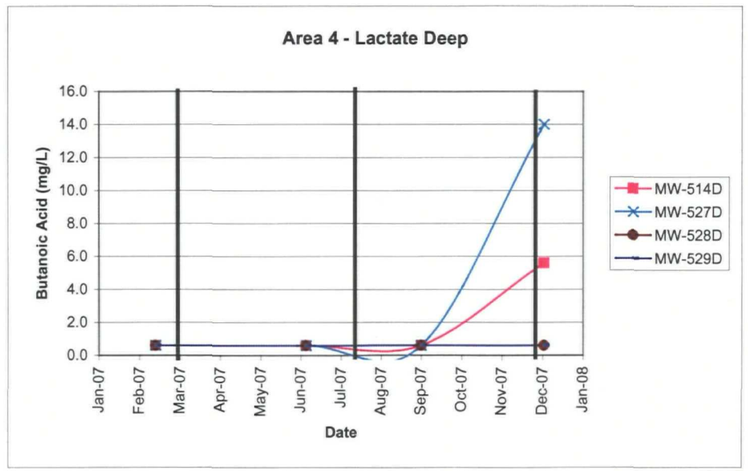


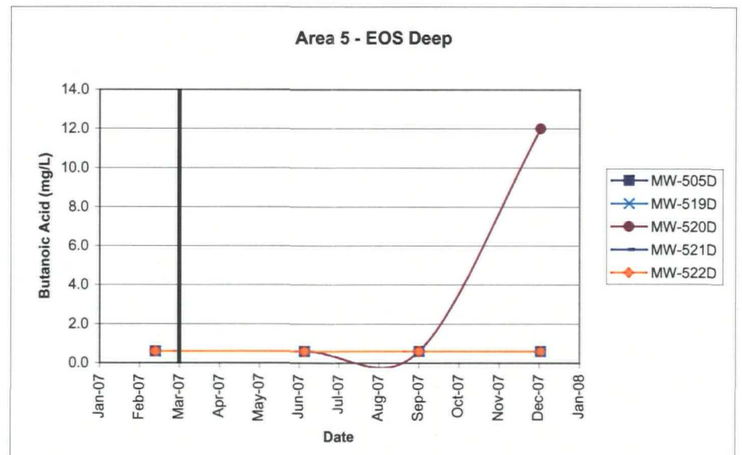
Butanoic Acid

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	0.6	0.6	0.6	1
MW-514D	0.6	0.6	0.6	6
MW-527S	0.6	0.6	0.6	1
MW-527D	0.6	0.6	0.6	14
MW-528S	0.6	0.6	0.6	1
MW-528D	0.6	0.6	0.6	1
MW-529S	0.6	0.6	0.6	1
MW-529D	0.6	0.6	0.6	1
Area 5				
MW-505S	0.6	0.6	0.6	1
MW-505D	0.6	0.6	0.6	1
MW-519S	0.6	0.6	0.6	1
MW-519D	0.6	0.6	0.6	1
MW-520S	NS	0.6	0.6	1
MW-520D	0.6	0.6	0.6	12
MW-521S	0.6	0.6	0.6	1
MW-521D	0.6	0.6	0.6	1
MW-522S	0.6	0.6	0.6	1
MW-522D	0.6	0.6	0.6	1



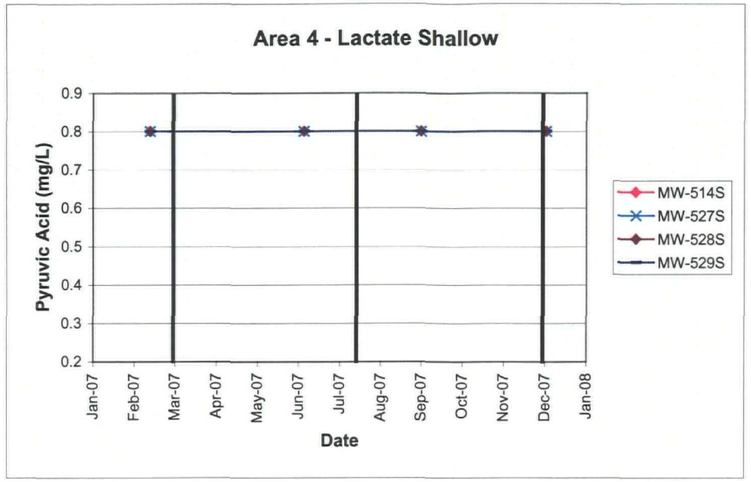


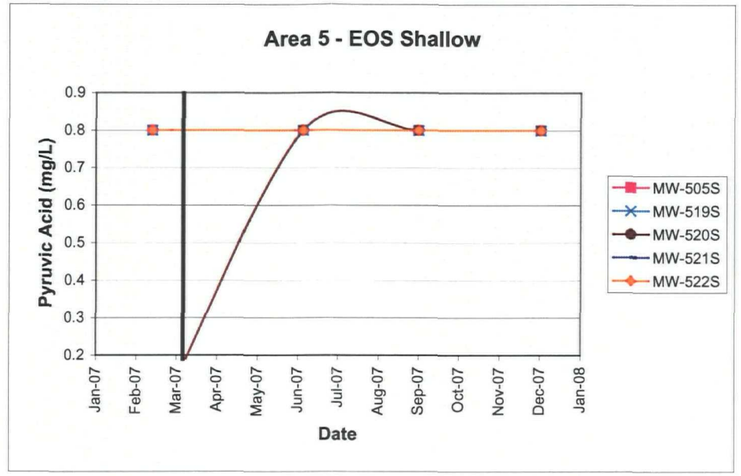


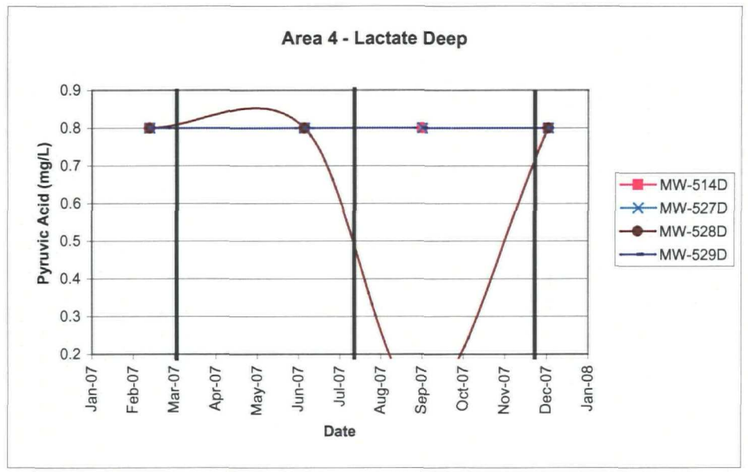


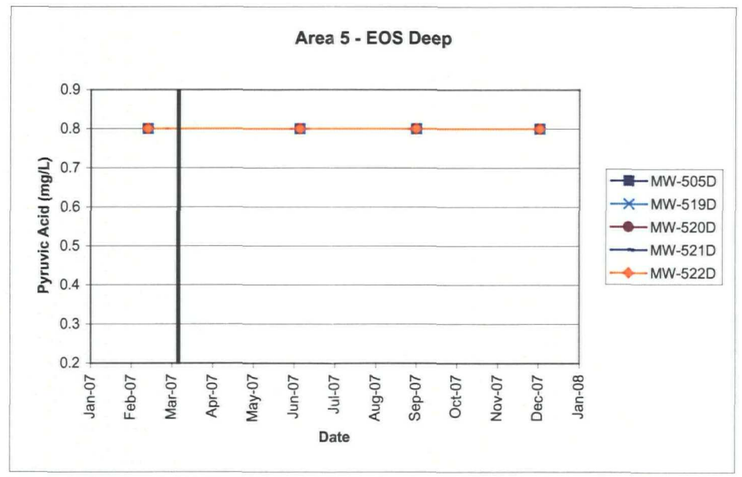
Pyruvic Acid

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	0.8	0.8	0.8	1
MW-514D	0.8	0.8	0.8	1
MW-527S	0.8	0.8	0.8	1
MW-527D	0.8	0.8	0.8	1
MW-528S	0.8	0.8	0.8	1
MW-528D	0.8	0.8	0.1	1
MW-529S	0.8	0.8	0.8	1
MW-529D	0.8	0.8	0.8	1
Area 5				
MW-505S	0.8	0.8	0.8	1
MW-505D	0.8	0.8	0.8	1
MW-519S	0.8	0.8	0.8	1
MW-519D	0.8	0.8	0.8	1
MW-520S	NS	0.8	0.8	1
MW-520D	0.8	0.8	0.8	1
MW-521S	0.8	0.8	0.8	1
MW-521D	0.8	0.8	0.8	1
MW-522S	0.8	0.8	0.8	1
MW-522D	0.8	0.8	0.8	1



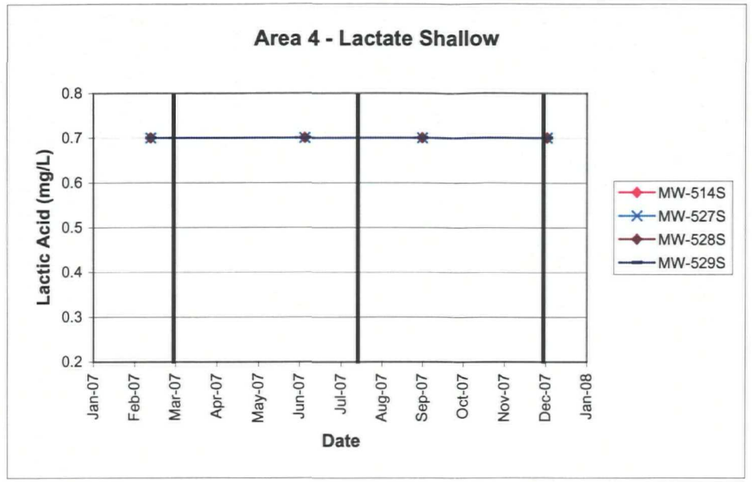


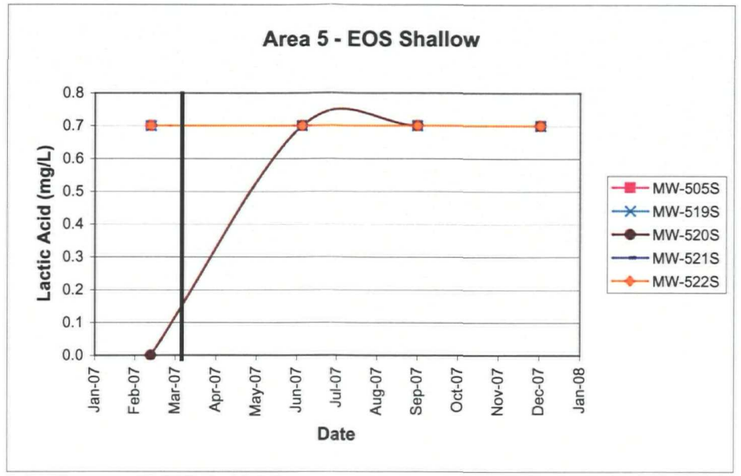


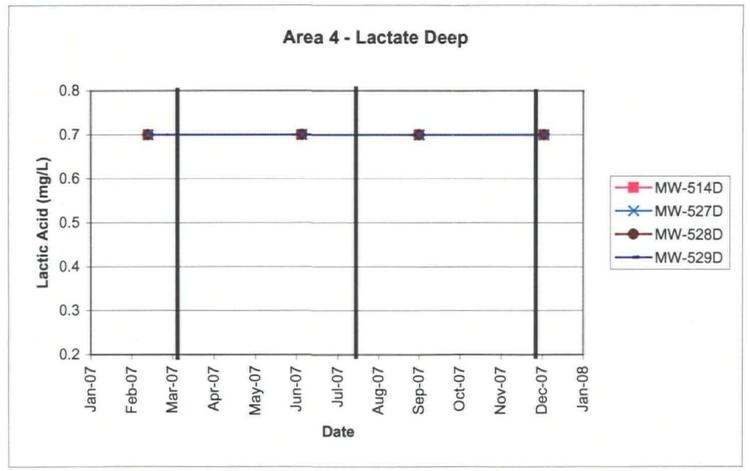


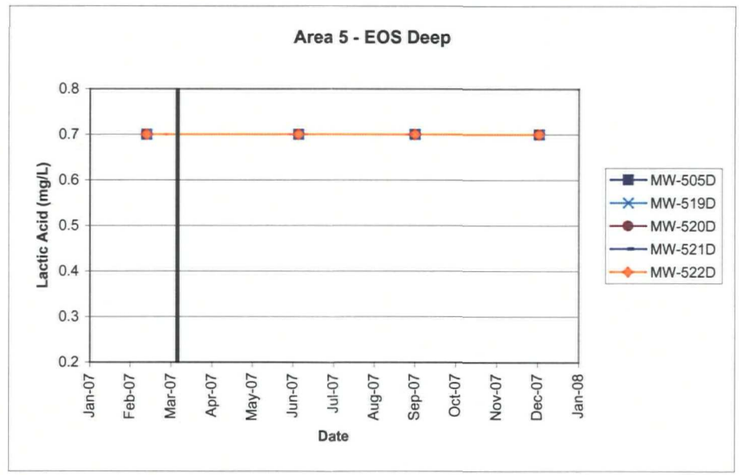
Lactic Acid

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	0.7	0.7	0.7	1
MW-514D	0.7	0.7	0.7	1
MW-527S	0.7	0.7	0.7	1
MW-527D	0.7	0.7	0.7	1
MW-528S	0.7	0.7	0.7	1
MW-528D	0.7	0.7	0.7	1
MW-529S	0.7	0.7	0.7	1
MW-529D	0.7	0.7	0.7	1
Area 5				
MW-505S	0.7	0.7	0.7	1
MW-505D	0.7	0.7	0.7	1
MW-519S	0.7	0.7	0.7	1
MW-519D	0.7	0.7	0.7	1
MW-520S	NS	0.7	0.7	1
MW-520D	0.7	0.7	0.7	1
MW-521S	0.7	0.7	0.7	1
MW-521D	0.7	0.7	0.7	1
MW-522S	0.7	0.7	0.7	1
MW-522D	0.7	0.7	0.7	1



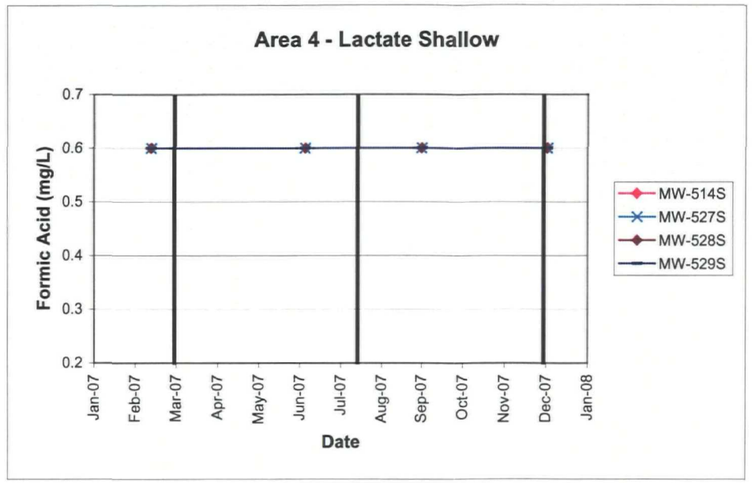


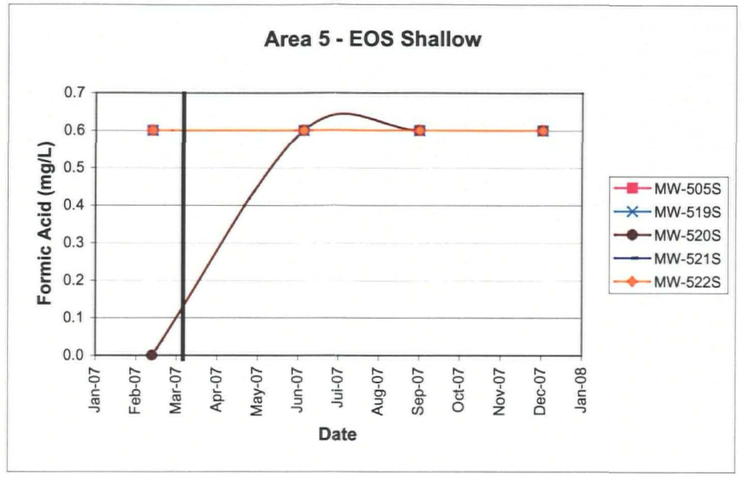


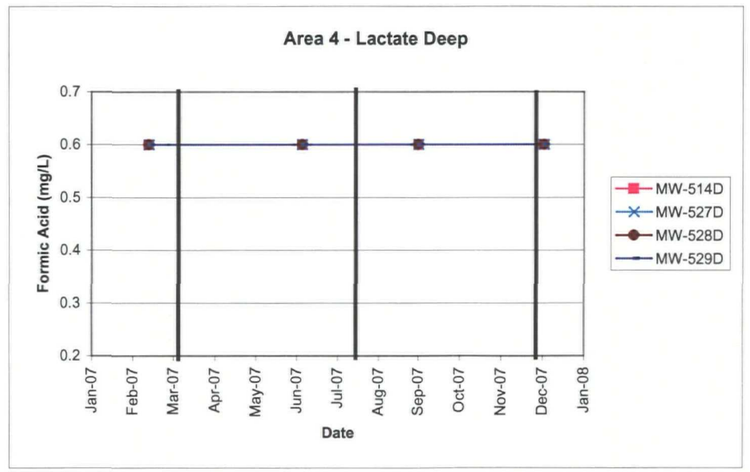


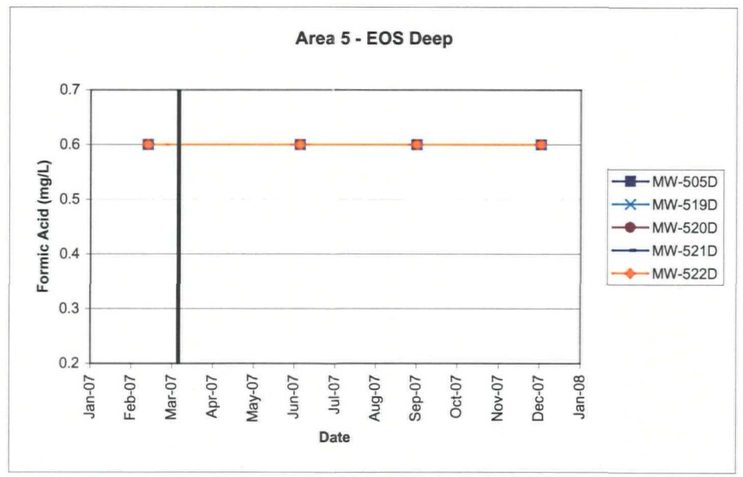
Formic Acid

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	0.6	0.6	0.6	1
MW-514D	0.6	0.6	0.6	1
MW-527S	0.6	0.6	0.6	1
MW-527D	0.6	0.6	0.6	1
MW-528S	0.6	0.6	0.6	1
MW-528D	0.6	0.6	0.6	1
MW-529S	0.6	0.6	0.6	1
MW-529D	0.6	0.6	0.6	1
Area 5				
MW-505S	0.6	0.6	0.6	1
MW-505D	0.6	0.6	0.6	1
MW-519S	0.6	0.6	0.6	1
MW-519D	0.6	0.6	0.6	1
MW-520S	NS	0.6	0.6	1
MW-520D	0.6	0.6	0.6	1
MW-521S	0.6	0.6	0.6	1
MW-521D	0.6	0.6	0.6	1
MW-522S	0.6	0.6	0.6	1
MW-522D	0.6	0.6	0.6	1



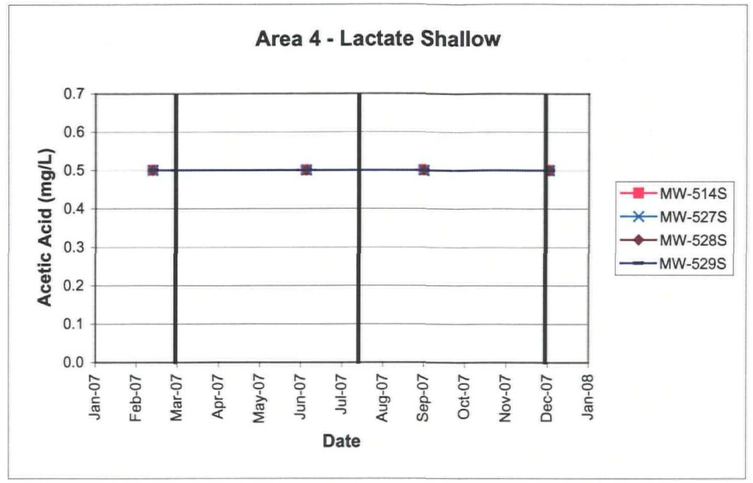


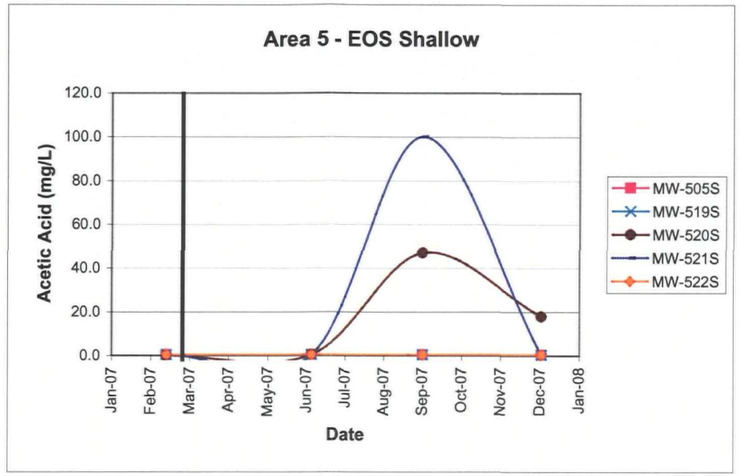


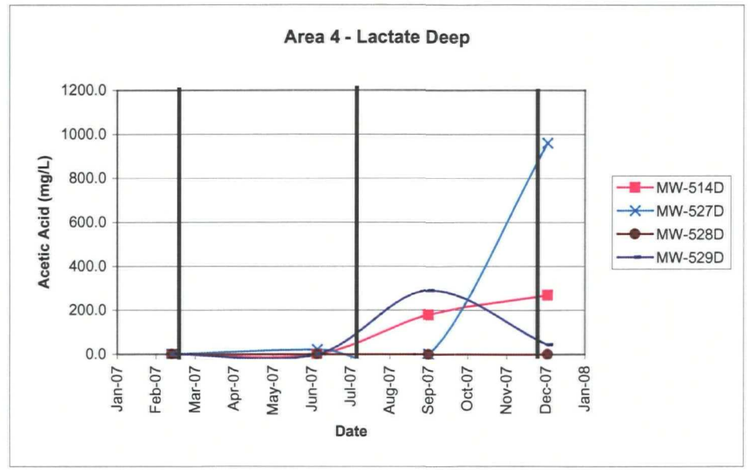


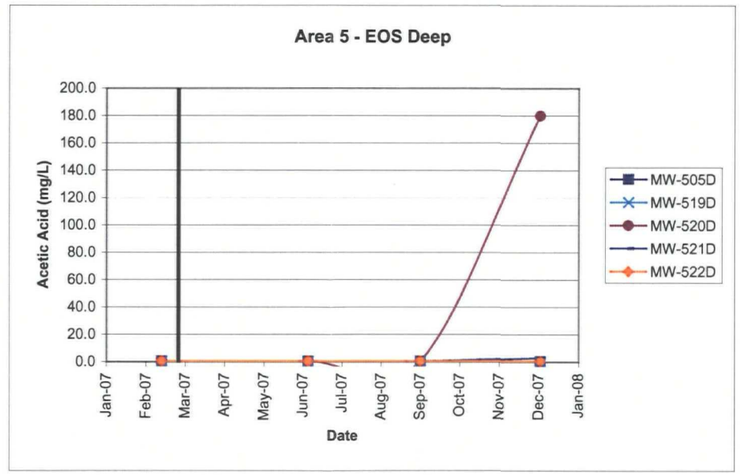
Acetic Acid

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	0.5	0.5	0.5	1
MW-514D	0.5	0.5	180.0	270
MW-527S	0.5	0.5	0.5	1
MW-527D	0.5	22.0	0.5	960
MW-528S	0.5	0.5	0.5	1
MW-528D	0.5	0.5	0.5	1
MW-529S	0.5	0.5	0.5	1
MW-529D	0.5	0.5	290.0	44
Area 5				
MW-505S	0.5	0.5	0.5	1
MW-505D	0.5	0.5	0.5	1
MW-519S	0.5	0.5	0.5	1
MW-519D	0.5	0.5	0.5	1
MW-520S	NS	0.5	47.0	18
MW-520D	0.5	0.5	0.5	180
MW-521S	0.5	0.5	100.0	1
MW-521D	0.5	0.5	0.5	3
MW-522S	0.5	0.5	0.5	1
MW-522D	0.5	0.5	0.5	1



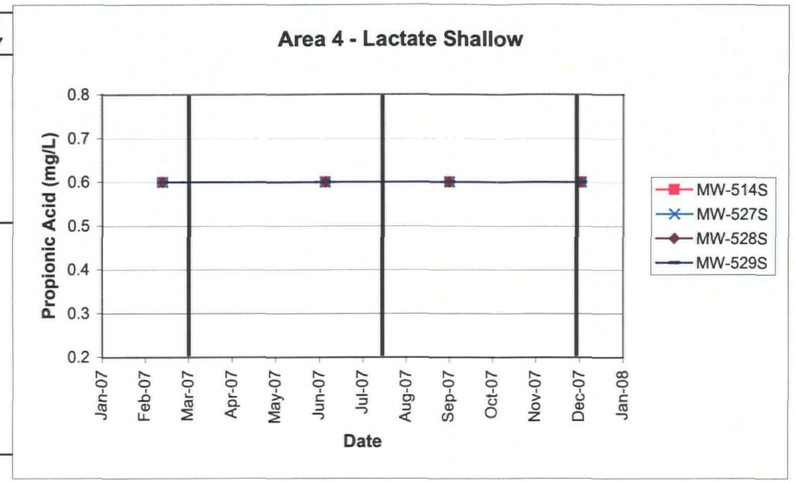


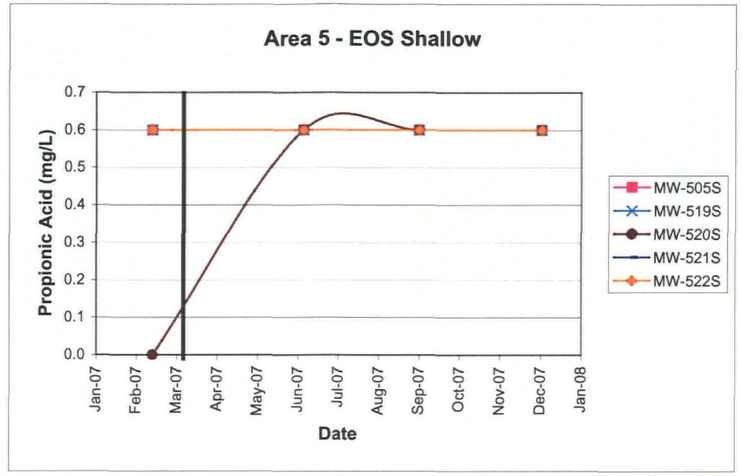


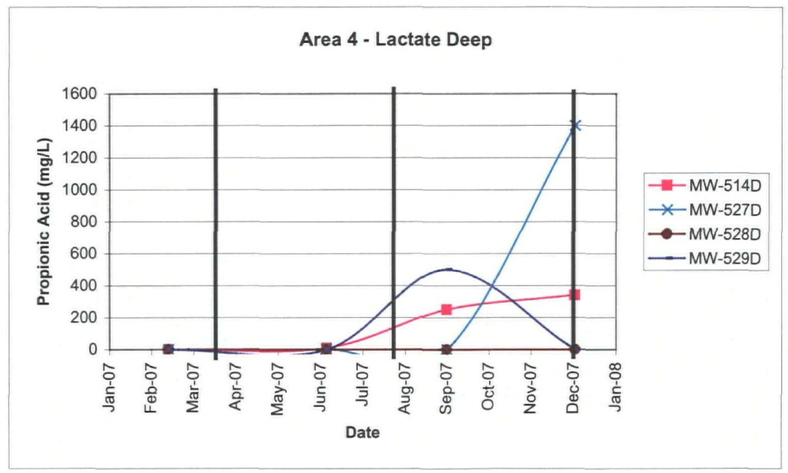


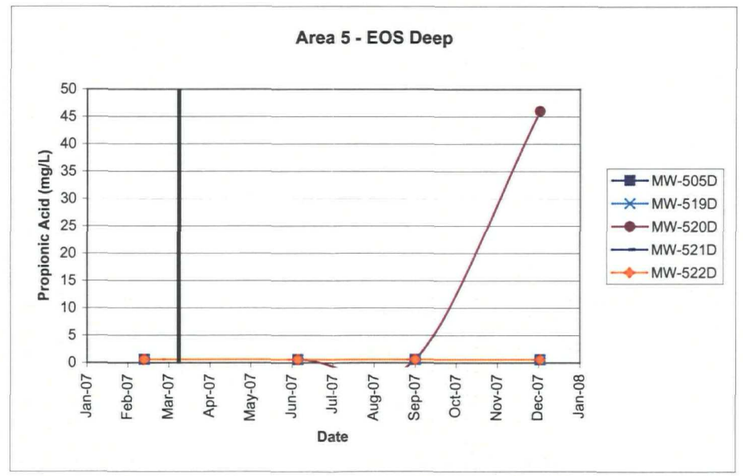
Propionic Acid

Area 4	Baseline 19-Feb-07	Primary 11-Jun-07	Primary 5-Sep-07	Primary 5-Dec-07
MW-514S	0.6	0.6	0.6	1
MW-514D	0.6	10.0	250.0	340
MW-527S	0.6	0.6	0.6	1
MW-527D	0.6	2.3	0.6	1,400
MW-528S	0.6	0.6	0.6	1
MW-528D	0.6	0.6	0.6	1
MW-529S	0.6	0.6	0.6	1
MW-529D	0.6	0.6	500.0	1
Area 5				
MW-505S	0.6	0.6	0.6	1
MW-505D	0.6	0.6	0.6	1
MW-519S	0.6	0.6	0.6	1
MW-519D	0.6	0.6	0.6	1
MW-520S	NS	0.6	0.6	1
MW-520D	0.6	0.6	0.6	46
MW-521S	0.6	0.6	0.6	1
MW-521D	0.6	0.6	0.6	1
MW-522S	0.6	0.6	0.6	1
MW-522D	0.6	0.6	0.6	1





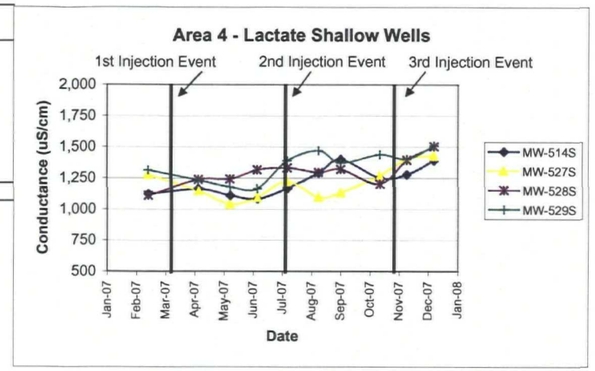


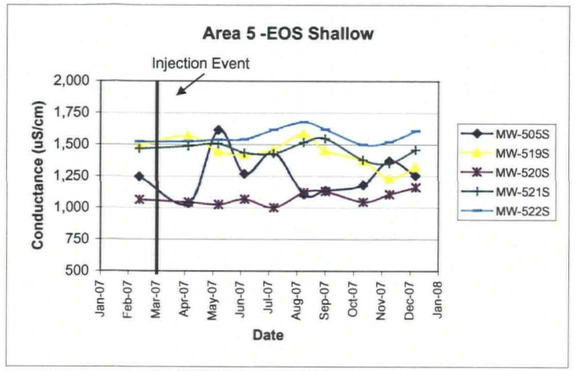


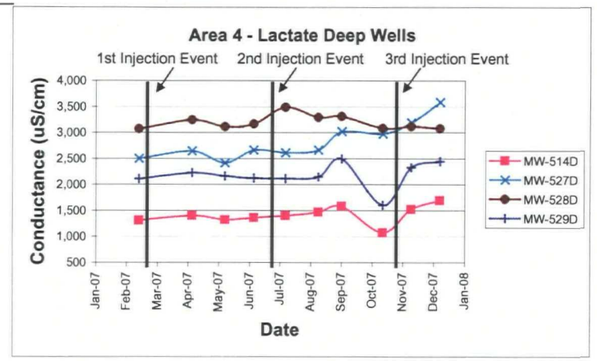
Specific Conductance (µS/cm°)

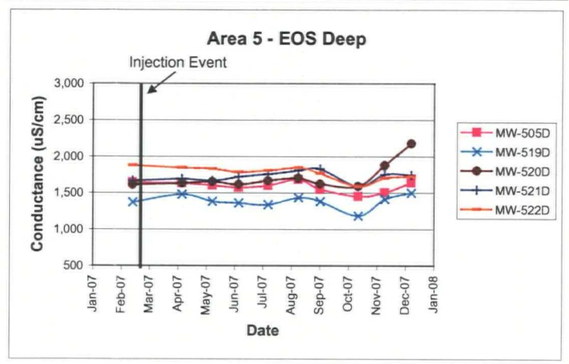
Area 4	Baseline 19-Feb-07	Secondary 12-Apr-07	Secondary 14-May-07	Primary 11-Jun-07	Secondary 12-Jul-07	Secondary 13-Aug-07	Primary 5-Sep-07	Secondary 15-Oct-07	Secondary 12-Nov-07	Primary 10-Dec-07
MW-514S	1,121	1,162	1,110	1,082	1,168	1,290	1,399	1,249	1,277	1,390
MW-514D	1,310	1,404	1,323	1,363	1,403	1,472	1,581	1,075	1,525	1,694
MW-527S	1,274	1,147	1,038	1,093	1,219	1,094	1,130	1,264	1,400	1,426
MW-527D	2,499	2,643	2,415	2,666	2,609	2,666	3,020	2,978	3,190	3,587
MW-528S	1,110	1,237	1,242	1,316	1,332	1,295	1,320	1,202	1,392	1,502
MW-528D	3,068	3,246	3,112	3,164	3,487	3,292	3,313	3,083	3,117	3,081
MW-529S	1,313	1,234	1,179	1,164	1,389	1,471	1,370	1,437	1,400	1,508
MW-529D	2,111	2,227	2,162	2,124	2,113	2,146	2,495	1,603	2,328	2,446
Area 5										
MW-505S	1,244	1,035	1,614	1,268	1,437	1,104	1,134	1,179	1,370	1,253
MW-505D	1,643	1,634	1,605	1,575	1,602	1,685	1,551	1,454	1,506	1,640
MW-519S	1,488	1,564	1,441	1,415	1,456	1,582	1,450	1,369	1,227	1,317
MW-519D	1,372	1,480	1,383	1,362	1,338	1,437	1,383	1,186	1,416	1,503
MW-520S	1,062	1,044	1,025	1,066	1,000	1,120	1,128	1,045	1,105	1,161
MW-520D	1,614	1,635	1,655	1,615	1,668	1,704	1,624	1,592	1,879	2,180
MW-521S	1,466	1,486	1,506	1,433	1,428	1,515	1,546	1,378	1,352	1,458
MW-521D	1,668	1,694	1,667	1,721	1,759	1,808	1,829	1,590	1,755	1,745
MW-522S	1,521	1,524	1,535	1,540	1,616	1,676	1,617	1,497	1,520	1,606
MW-522D	1,878	1,844	1,831	1,785	1,808	1,846	1,770	1,587	1,703	1,728

NOT read - averaged based on Feb and May readings as a placeholder.





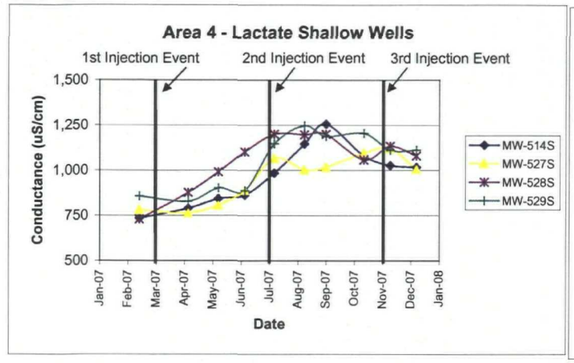


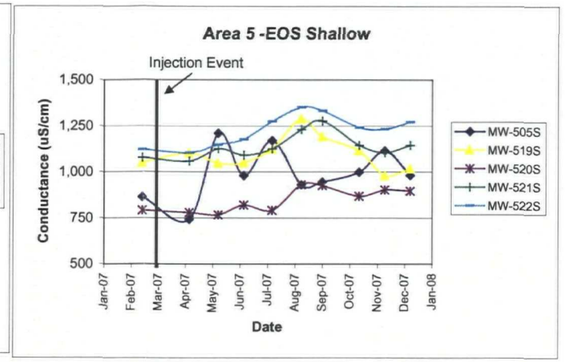


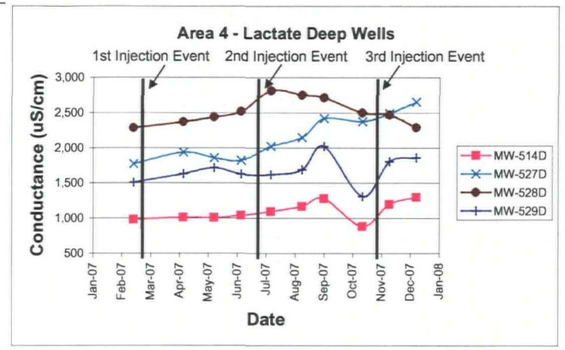
Conductivity (µS/cm)

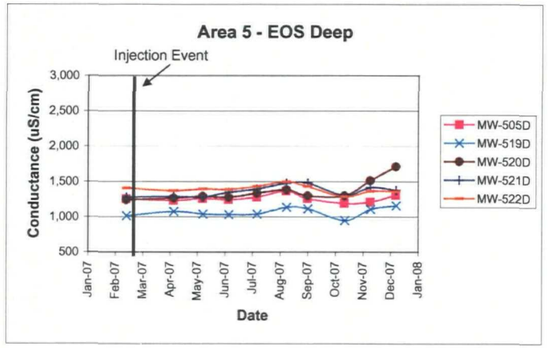
Area 4	Baseline 19-Feb-07	Secondary 12-Apr-07	Secondary 14-May-07	Primary 11-Jun-07	Secondary 12-Jul-07	Secondary 13-Aug-07	Primary 5-Sep-07	Secondary 15-Oct-07	Secondary 12-Nov-07	Primary 10-Dec-07
MW-514S	735	789	842	862	985	1,146	1,256	1,080	1,026	1,017
MW-514D	981	1,012	1,008	1,039	1,096	1,170	1,282	886	1,198	1,299
MW-527S	779	762	805	888	1,064	1,003	1,015	1,094	1,121	1,006
MW-527D	1,771	1,937	1,857	1,821	2,025	2,149	2,420	2,378	2,493	2,655
MW-528S	729	877	990	1,101	1,200	1,197	1,200	1,058	1,134	1,080
MW-528D	2,282	2,369	2,437	2,517	2,812	2,750	2,715	2,498	2,472	2,290
MW-529S	857	829	901	887	1,147	1,247	1,188	1,205	1,111	1,112
MW-529D	1,509	1,632	1,718	1,628	1,621	1,693	2,022	1,312	1,809	1,861
Area 5										
MW-505S	864	741	1,209	980	1,170	930	945	999	1,115	981
MW-505D	1,256	1,232	1,258	1,243	1,279	1,364	1,257	1,191	1,206	1,303
MW-519S	1,048	1,101	1,046	1,048	1,122	1,287	1,190	1,114	980	1,016
MW-519D	1,014	1,074	1,040	1,033	1,038	1,134	1,116	950	1,107	1,157
MW-520S	791	779	766	819	790	930	925	868	902	896
MW-520D	1,239	1,265	1,291	1,276	1,332	1,384	1,299	1,298	1,513	1,709
MW-521S	1,077	1,058	1,126	1,091	1,125	1,230	1,277	1,145	1,105	1,145
MW-521D	1,281	1,288	1,280	1,348	1,396	1,476	1,480	1,301	1,417	1,378
MW-522S	1,121	1,103	1,148	1,176	1,274	1,351	1,332	1,241	1,233	1,270
MW-522D	1,405	1,370	1,394	1,386	1,432	1,496	1,430	1,288	1,363	1,357

NOT read - averaged based on Feb and May readings as a placeholder.





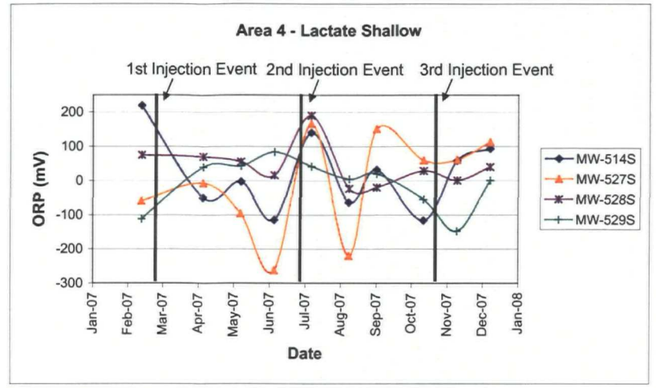


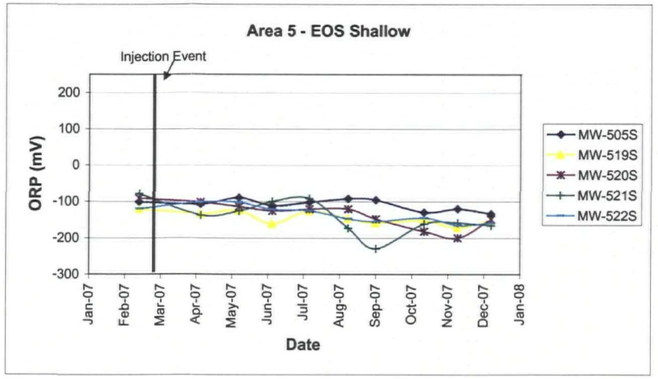


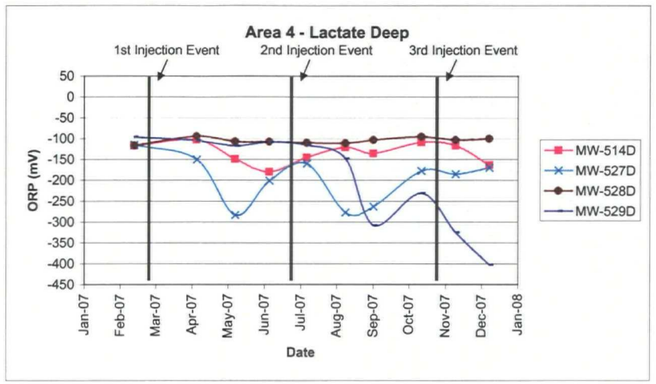
ORP (mV)

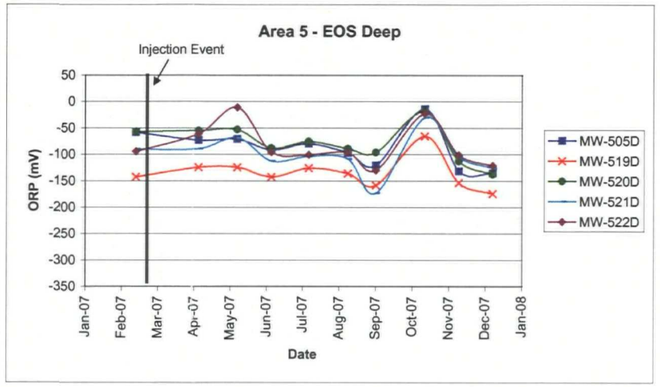
Area 4	Baseline 19-Feb-07	Secondary 12-Apr-07	Secondary 14-May-07	Primary 11-Jun-07	Secondary 12-Jul-07	Secondary 13-Aug-07	Primary 5-Sep-07	Secondary 15-Oct-07	Secondary 12-Nov-07	Primary 10-Dec-07
MW-514S	218.6	-50.7	-3.4	-115.3	140.3	-63.9	31.9	-116.4	57.6	93
MW-514D	-117.1	-102.7	-148.9	-179.7	-145.3	-120.6	-135	-108.7	-116.6	-163
MW-527S	-60	-8.6	-96.8	-262.7	166.1	-220.9	150.9	58.2	60	111.6
MW-527D	-114.6	-150	-282.8	-201.2	-159.9	-276.9	-263	-177	-185.1	-170.2
MW-528S	74.3	70	55	15.2	190	-23.8	-20	28.4	-0.2	39.4
MW-528D	-116.5	-94.1	-106.5	-107.3	-110	-111.2	-103.3	-95.2	-103.2	-99.9
MW-529S	-111.9	39.5	43.1	83.9	41.6	4.3	19.9	-54.7	-148.2	-0.3
MW-529D	-95.9	-104.2	-117.3	-108.1	-115	-147.6	-308	-230.6	-325.1	-402.9
Area 5										
MW-505S	-101.2	-107	-88.9	-110.6	-101.6	-92	-95.4	-129.5	-120.2	-133.8
MW-505D	-58.2	-72.9	-70.5	-91.5	-79.3	-97.1	-120.3	-14.2	-131.6	-135.3
MW-519S	-120.7	-133.8	-125.2	-162	-126.8	-146.5	-160	-151.9	-172.1	-151.7
MW-519D	-142.5	-124.2	-124.5	-142.5	-125.7	-135.7	-158.5	-65.3	-153.6	-174
MW-520S	-90.9	-101.85	-113.7	-125.4	-120.9	-120.8	-147.6	-182	-200.2	-148.8
MW-520D	-57	-54.9	-52.8	-88.1	-75.6	-88.7	-96	-17.8	-113.1	-137.6
MW-521S	-77.9	-137.5	-125.7	-99.4	-91.3	-172.8	-229.3	-161.2	-158.2	-166.2
MW-521D	-89.9	-89.5	-67.8	-112.6	-103.2	-108.7	-173	-29.8	-104.9	-126
MW-522S	-119.1	-101.2	-102	-121.6	-125	-146.8	-154.6	-145.1	-165.4	-159.3
MW-522D	-94.2	-60.9	-10.6	-95.8	-100.2	-96.5	-130	-22.9	-100.8	-121.2

NOT read - averaged based on Feb and May readings as a placeholder.



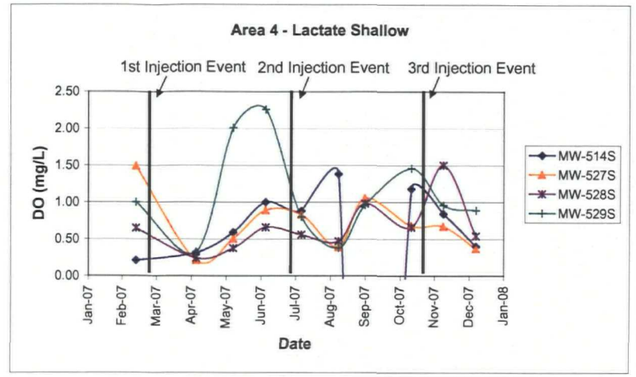


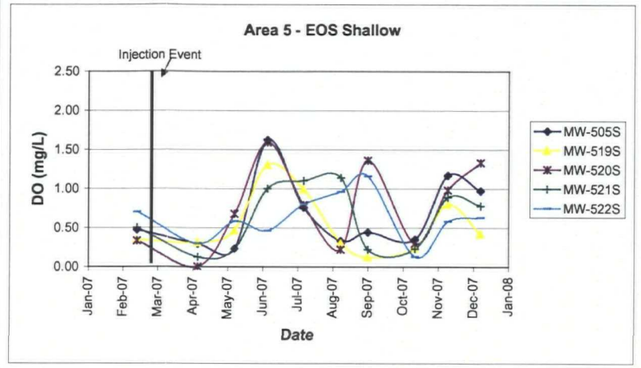


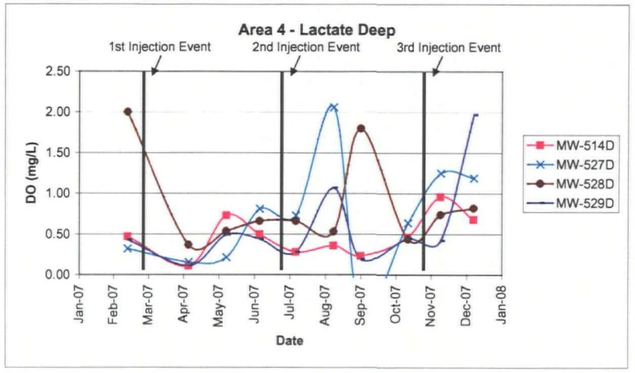


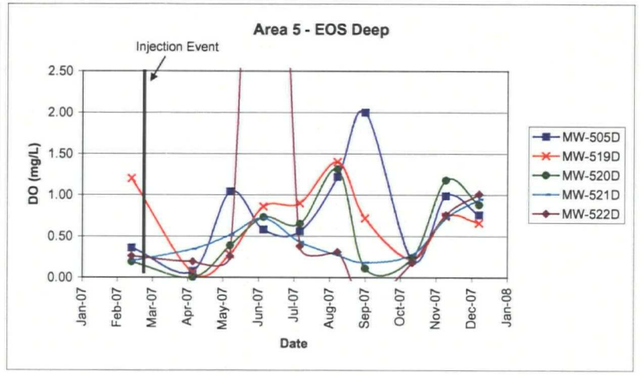
Dissolved Oxygen (mg/L)

Area 4	Baseline 19-Feb-07	Secondary 12-Apr-07	Secondary 14-May-07	Primary 11-Jun-07	Secondary 12-Jul-07	Secondary 13-Aug-07	Primary 5-Sep-07	Secondary 15-Oct-07	Secondary 12-Nov-07	Primary 10-Dec-07
MW-514S	0.21	0.32	0.59	1.00	0.88	1.38	-10.18	1.18	0.84	0.4
MW-514D	0.47	0.11	0.73	0.50	0.28	0.36	0.23	0.46	0.96	0.68
MW-527S	1.49	0.21	0.50	0.89	0.83	0.39	1.05	0.68	0.67	0.37
MW-527D	0.32	0.16	0.21	0.81	0.73	2.06	-0.44	0.64	1.25	1.19
MW-528S	0.65	0.24	0.38	0.66	0.56	0.47	0.98	0.66	1.5	0.54
MW-528D	2.00	0.37	0.54	0.66	0.66	0.53	1.8	0.44	0.74	0.82
MW-529S	1.00	0.33	2.01	2.26	0.8	0.38	0.96	1.46	0.96	0.89
MW-529D	0.43	0.11	0.49	0.44	0.28	1.07	0.19	0.45	0.42	1.97
Area 5										
MW-505S	0.47	0.29	0.23	1.62	0.76	0.33	0.44	0.35	1.17	0.97
MW-505D	0.36	0.08	1.04	0.58	0.56	1.22	2	0.21	0.99	0.76
MW-519S	0.34	0.31	0.46	1.30	0.99	0.31	0.12	0.24	0.8	0.42
MW-519D	1.20	0.06	0.28	0.86	0.9	1.4	0.72	0.22	0.74	0.66
MW-520S	0.33	0.00	0.68	1.59	0.79	0.22	1.36	0.3	0.98	1.33
MW-520D	0.19	0.00	0.39	0.73	0.65	1.31	0.11	0.24	1.18	0.88
MW-521S	0.50	0.12	0.23	1.00	1.1	1.14	0.22	0.23	0.89	0.78
MW-521D	0.20	0.35	0.52	0.72	0.43	0.27	0.18	0.28	0.72	0.95
MW-522S	0.70	0.29	0.58	0.46	0.8	0.96	1.16	0.13	0.58	0.63
MW-522D	0.26	0.19	0.26	8.80	0.38	0.31	-0.28	0.18	0.76	1.01





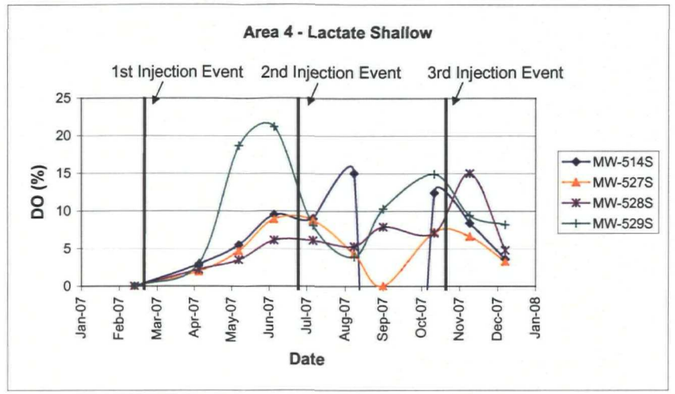


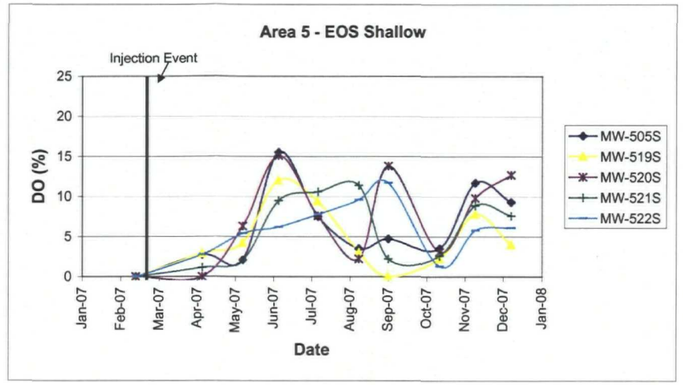


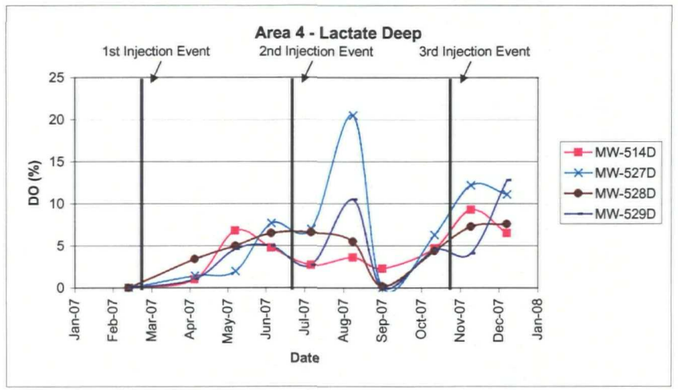
Dissolved Oxygen (%)

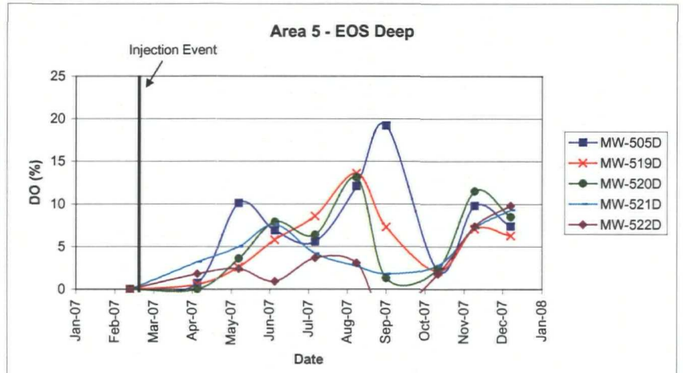
Area 4	Baseline 19-Feb-07	Secondary 12-Apr-07	Secondary 14-May-07	Primary 11-Jun-07	Secondary 12-Jul-07	Secondary 13-Aug-07	Primary 5-Sep-07	Secondary 15-Oct-07	Secondary 12-Nov-07	Primary 10-Dec-07
MW-514S	NM	2.94	5.50	9.50	9.00	15.00	-99.90	12.40	8.40	3.60
MW-514D	NM	1.01	6.80	4.80	2.70	3.60	2.30	4.70	9.30	6.50
MW-527S	NM	1.96	4.70	8.90	8.80	4.30	NM	7.20	6.60	3.30
MW-527D	NM	1.45	2.00	7.70	7.00	20.50	NM	6.30	12.20	11.10
MW-528S	NM	2.24	3.50	6.10	6.10	5.30	7.90	7.10	15.00	4.80
MW-528D	NM	3.43	5.00	6.50	6.60	5.50	0.18	4.40	7.30	7.60
MW-529S	NM	3.06	18.70	21.20	8.10	3.90	10.30	14.90	9.40	8.20
MW-529D	NM	1.05	4.60	5.00	2.70	10.50	nm	4.50	4.10	12.80
Area 5										
MW-505S	NM	2.73	2.10	15.50	7.50	3.50	4.70	3.50	11.70	9.30
MW-505D	NM	0.71	10.10	6.90	5.60	12.10	19.20	2.10	9.80	7.40
MW-519S	NM	2.88	4.20	12.00	9.40	3.10	0.00	2.20	7.80	4.00
MW-519D	NM	0.57	2.60	5.80	8.60	13.60	7.30	2.10	7.10	6.30
MW-520S	NM	0.00	6.30	15.10	7.60	2.20	13.80	3.10	9.80	12.70
MW-520D	NM	0.00	3.60	7.90	6.40	13.10	1.30	2.40	11.50	8.50
MW-521S	NM	1.15	2.10	9.50	10.60	11.40	2.20	2.60	8.90	7.60
MW-521D	NM	3.22	5.00	7.60	4.20	2.70	1.80	2.80	7.20	9.30
MW-522S	NM	2.74	5.40	6.20	7.80	9.60	11.70	1.30	5.80	6.10
MW-522D	NM	1.80	2.40	0.92	3.70	3.10	-3.00	1.80	7.40	9.80

NOT read - averaged based on Feb and May readings as a placeholder.





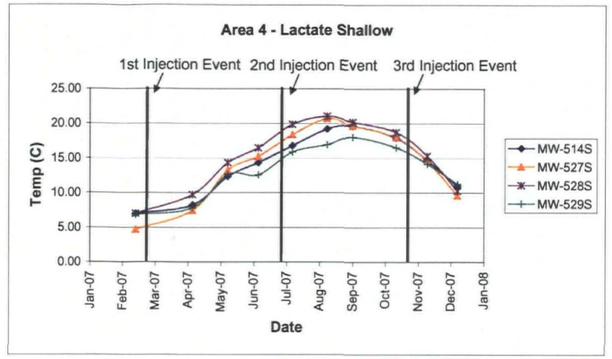


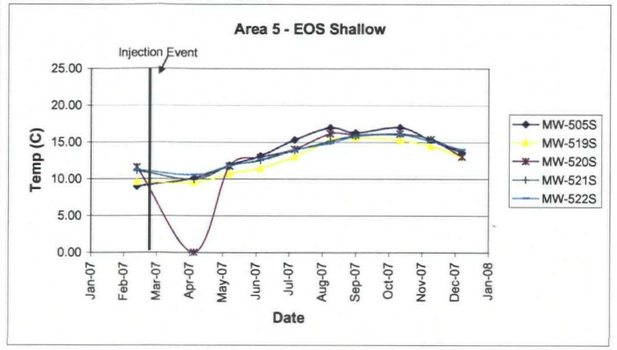


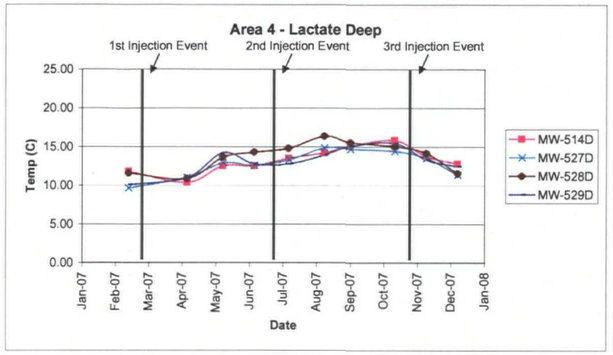
Temperature (deg C)

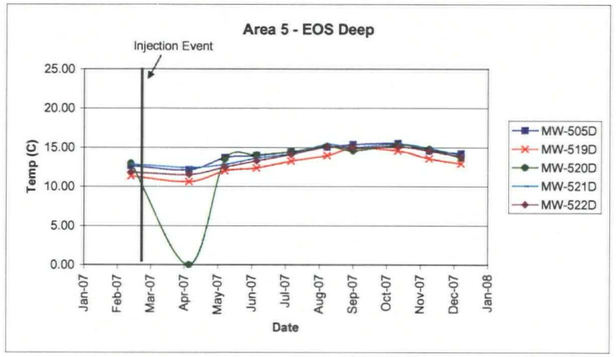
Area 4	Baseline 19-Feb-07	Secondary 12-Apr-07	Secondary 14-May-07	Primary 11-Jun-07	Secondary 12-Jul-07	Secondary 13-Aug-07	Primary 5-Sep-07	Secondary 15-Oct-07	Secondary 12-Nov-07	Primary 10-Dec-07
MW-514S	7.00	8.20	12.35	14.32	16.79	19.22	19.62	17.93	14.71	10.95
MW-514D	11.82	10.37	12.52	12.53	13.52	14.21	15.08	15.84	13.78	12.79
MW-527S	4.65	7.42	13.25	15.21	18.35	20.66	19.66	17.99	14.58	9.62
MW-527D	9.65	11.03	12.89	12.60	13.28	14.86	14.71	14.43	13.56	11.37
MW-528S	7.01	9.72	14.33	16.45	19.85	21.03	20.18	18.74	15.31	10.27
MW-528D	11.59	10.86	13.65	14.31	14.81	16.38	15.54	15.06	14.18	11.56
MW-529S	6.82	7.82	12.64	12.57	15.89	16.92	18.02	16.55	14.18	11.25
MW-529D	10.07	11.00	14.24	12.77	12.80	13.94	15.07	15.47	13.33	12.48
Area 5										
MW-505S	8.98	10.11	11.86	13.14	15.30	16.97	16.29	16.99	15.25	13.62
MW-505D	12.62	12.13	13.69	13.95	14.45	15.02	15.34	15.52	14.58	14.24
MW-519S	9.56	9.49	10.64	11.42	12.98	15.25	15.58	15.23	14.45	13.01
MW-519D	11.34	10.63	12.03	12.36	13.25	13.95	14.87	14.58	13.57	12.92
MW-520S	11.60	0.00	11.73	12.92	14.03	16.14	16.01	16.13	15.38	13.02
MW-520D	12.97	0.00	13.49	14.02	14.45	15.17	14.56	15.33	14.81	13.68
MW-521S	11.12	9.94	11.80	12.51	13.91	15.15	15.89	16.15	15.45	13.70
MW-521D	12.87	12.43	12.83	13.63	14.18	15.37	15.00	15.47	14.90	14.00
MW-522S	11.22	10.54	11.79	12.63	13.93	14.86	15.79	16.03	15.13	14.03
MW-522D	11.84	11.54	12.50	13.28	14.10	15.07	14.91	15.13	14.54	13.79

NOT read - averaged based on Feb and May readings as a placeholder.





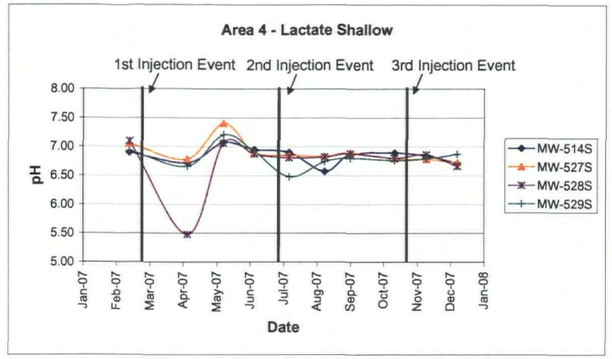


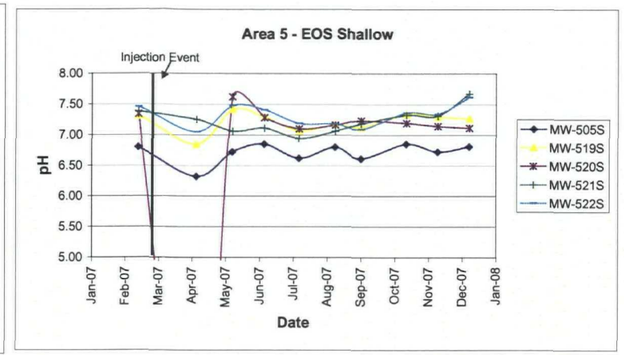


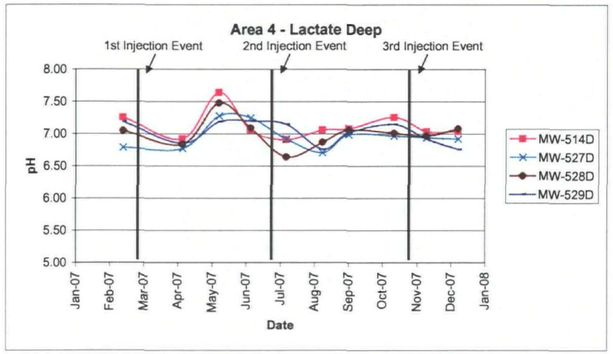
pH (SU)

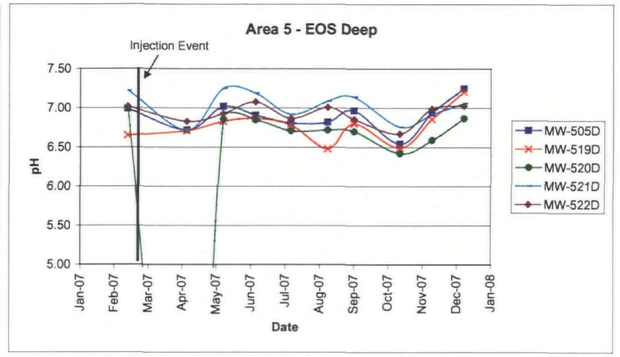
Area 4	Baseline 19-Feb-07	Secondary 12-Apr-07	Secondary 14-May-07	Primary 11-Jun-07	Secondary 12-Jul-07	Secondary 13-Aug-07	Primary 5-Sep-07	Secondary 15-Oct-07	Secondary 12-Nov-07	Primary 10-Dec-07
MW-514S	6.90	6.72	7.07	6.95	6.9	6.57	6.86	6.89	6.84	6.71
MW-514D	7.26	6.92	7.64	7.06	6.91	7.06	7.08	7.26	7.04	7.04
MW-527S	7.05	6.78	7.40	6.9	6.85	6.83	6.89	6.79	6.78	6.72
MW-527D	6.79	6.77	7.28	7.25	6.92	6.71	6.99	6.97	6.94	6.92
MW-528S	7.10	5.48	7.06	6.87	6.81	6.82	6.88	6.8	6.86	6.66
MW-528D	7.05	6.84	7.48	7.09	6.64	6.87	7.06	7.01	6.97	7.08
MW-529S	6.93	6.66	7.21	6.92	6.48	6.74	6.8	6.76	6.79	6.87
MW-529D	7.19	6.85	7.19	7.2	7.15	6.76	7.02	7.15	6.92	6.76
Area 5										
MW-505S	6.80	6.32	6.72	6.85	6.62	6.8	6.61	6.85	6.72	6.81
MW-505D	6.99	6.72	7.02	6.91	6.81	6.82	6.97	6.54	6.94	7.25
MW-519S	7.31	6.84	7.41	7.29	7.06	7.17	7.12	7.33	7.29	7.26
MW-519D	6.65	6.71	6.83	6.87	6.78	6.48	6.8	6.49	6.86	7.21
MW-520S	7.34	0.00	7.62	7.28	7.1	7.16	7.23	7.19	7.14	7.11
MW-520D	7.00	0.00	6.86	6.85	6.71	6.72	6.7	6.42	6.59	6.87
MW-521S	7.38	7.25	7.06	7.11	6.94	7.06	7.18	7.32	7.31	7.67
MW-521D	7.22	6.72	7.25	7.19	6.92	7.09	7.14	6.76	6.92	7.06
MW-522S	7.46	7.05	7.48	7.41	7.19	7.18	7.09	7.36	7.34	7.61
MW-522D	7.02	6.83	6.93	7.08	6.87	7.01	6.86	6.67	6.99	7.03

NOT read - averaged based on Feb and May readings as a placeholder.





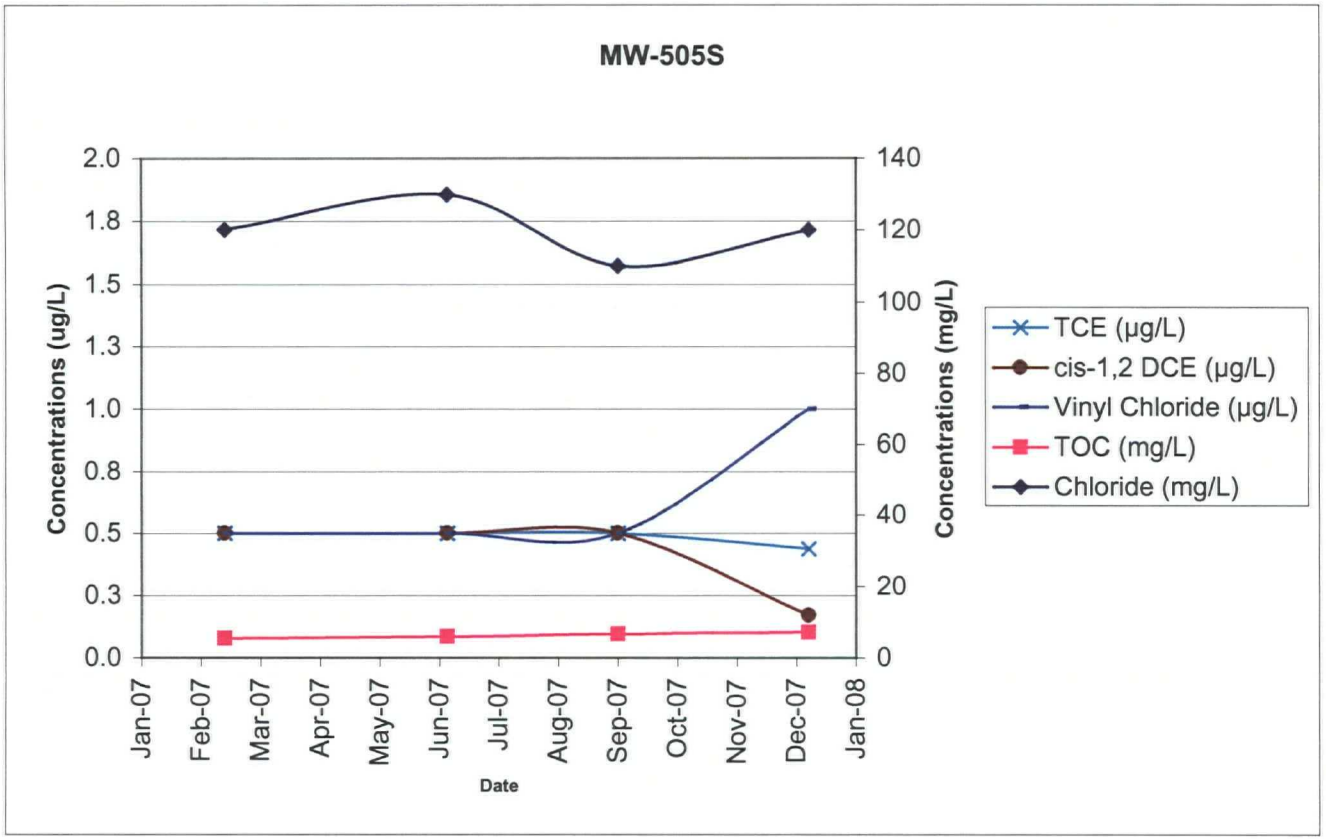




Appendix C
Individual Well Graphs

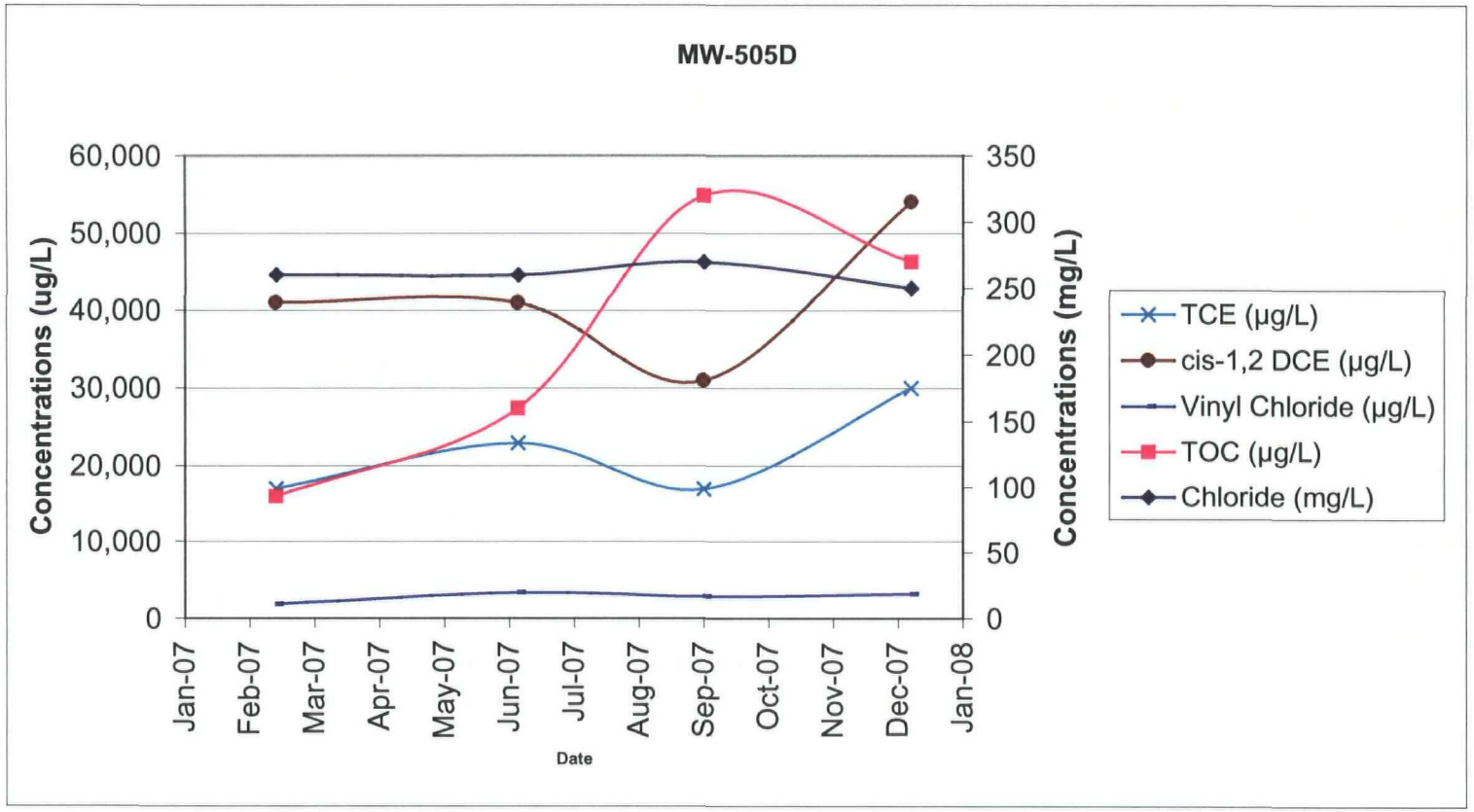
MW-505S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	5	5.9	6.7	7.1
TCE (µg/L)	0.50	0.50	0.50	0.4
cis-1,2 DCE (µg/L)	0.50	0.50	0.50	0.2
Vinyl Chloride (µg/L)	0.50	0.50	0.50	1.0
Chloride (mg/L)	120	130	110	120



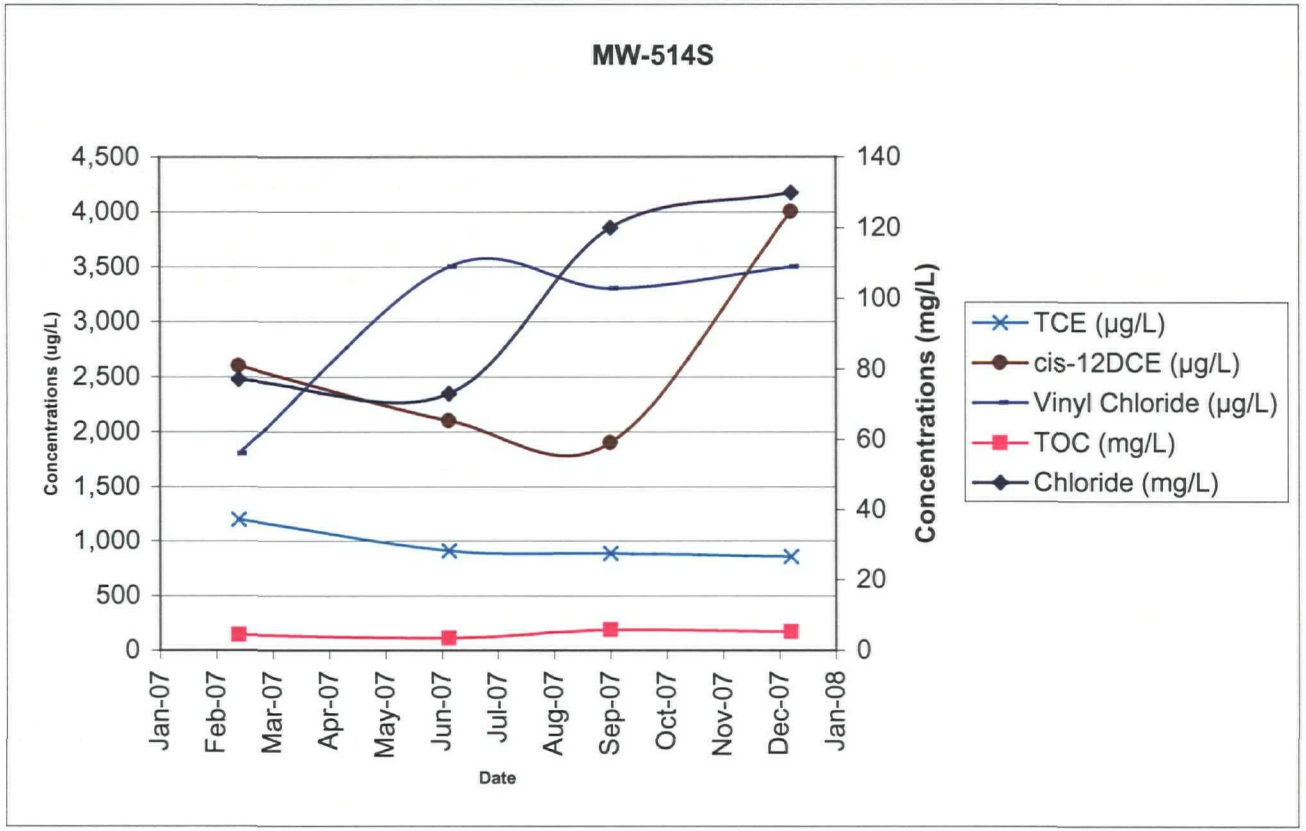
MW-505D

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (µg/L)	93	160	320	270
TCE (µg/L)	17000	23000	17000	30000
cis-1,2 DCE (µg/L)	41000	41000	31000	54000
Vinyl Chloride (µg/L)	1900	3400	2900	3200
Chloride (mg/L)	260	260	270	250



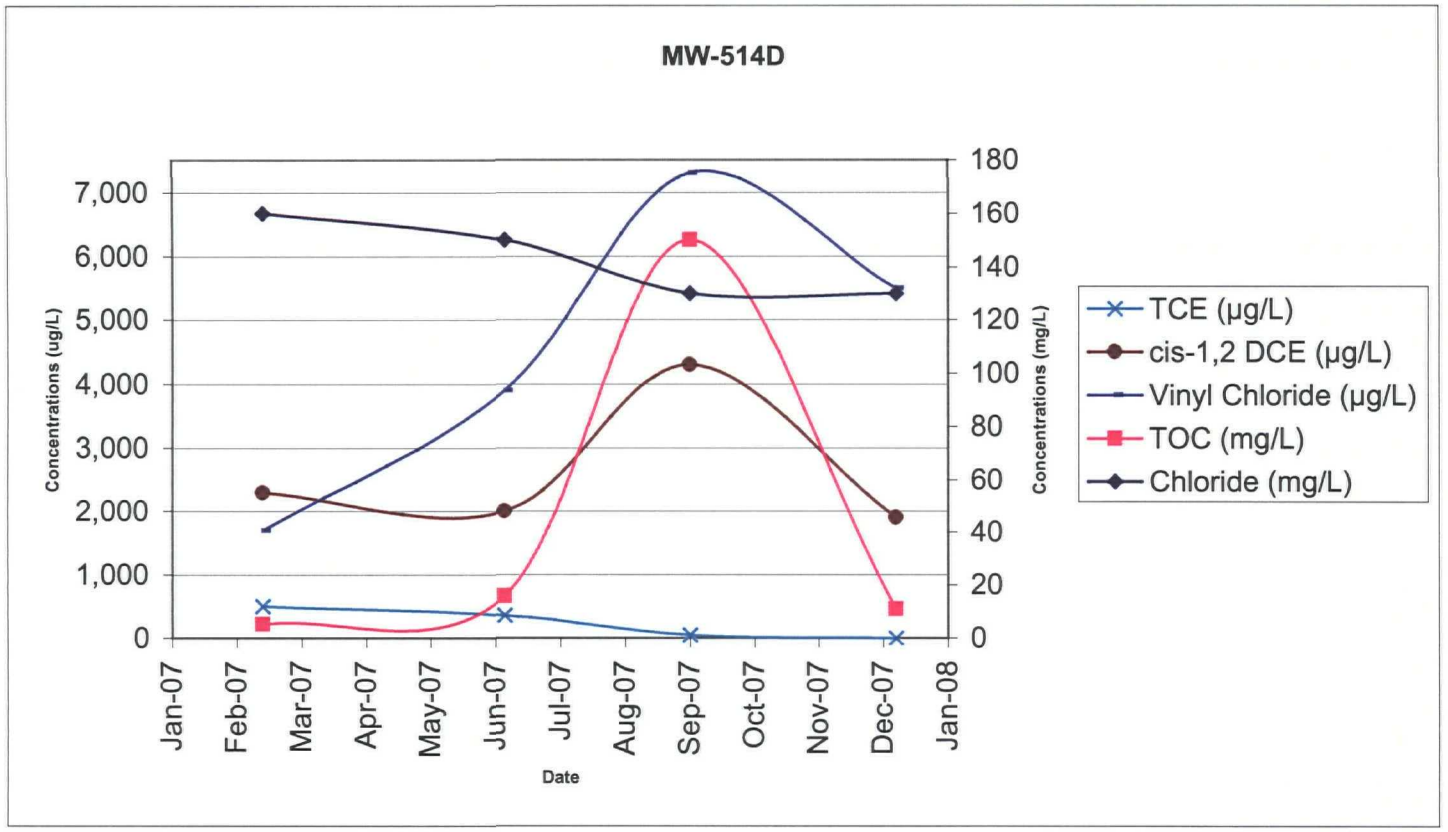
MW-514S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	4	3.5	5.8	5.3
TCE (µg/L)	1200	910	890	860
cis-12DCE (µg/L)	2600	2100	1900	4000
Vinyl Chloride (µg/L)	1800	3500	3300	3500
Chloride (mg/L)	77	73	120	130



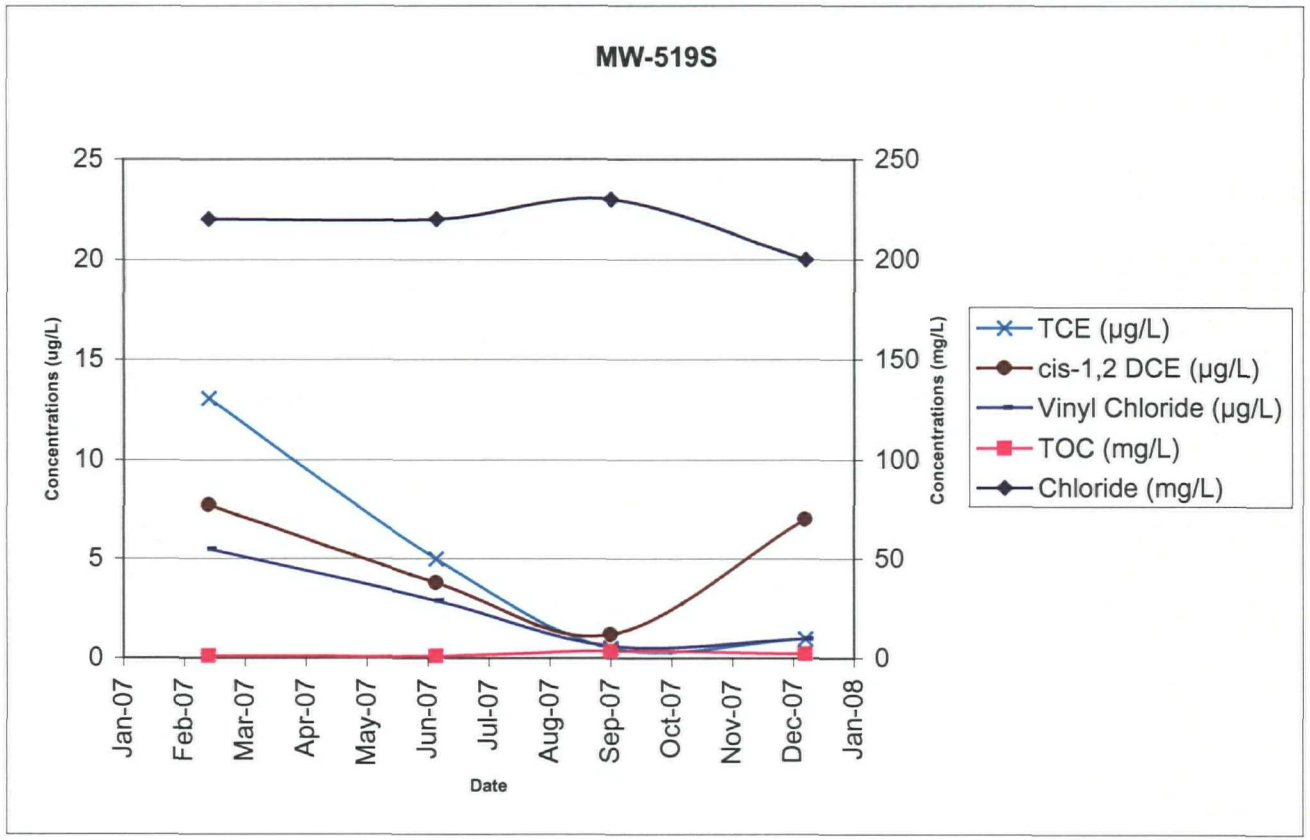
MW-514D

	Baseline **19-Feb-07**	primary **11-Jun-07**	primary **5-Sep-07**	primary **10-Dec-07**
TOC (mg/L)	5	16	150	11
TCE (µg/L)	500	360	50	1
cis-1,2 DCE (µg/L)	2300	2000	4300	1900
Vinyl Chloride (µg/L)	1700	3900	7300	5500
Chloride (mg/L)	160	150	130	130



MW-519S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	1	1.1	3.5	2.2
TCE (µg/L)	13	5	1	1
cis-1,2 DCE (µg/L)	8	4	1	7
Vinyl Chloride (µg/L)	6	3	1	1
Chloride (mg/L)	220	220	230	200

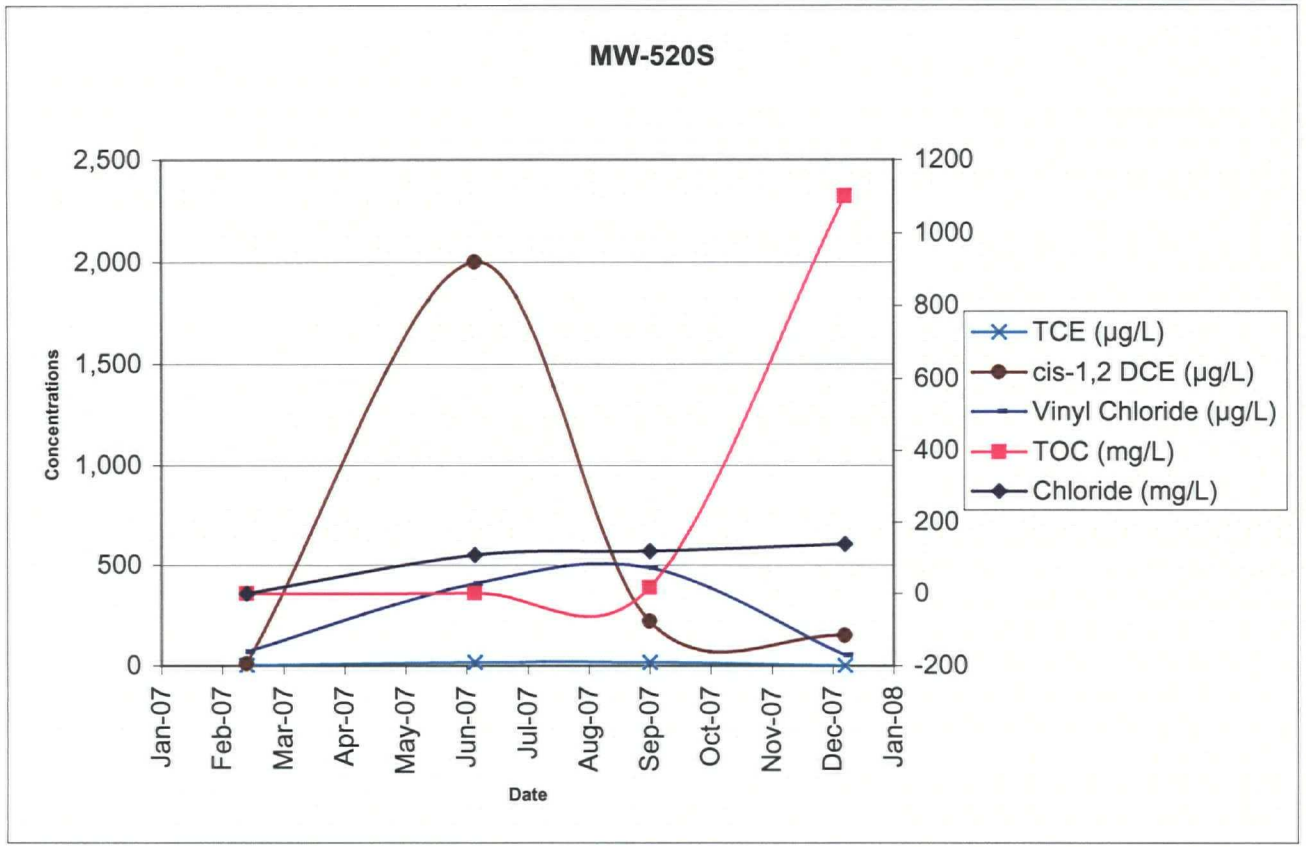


MW-519D

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (µg/L)	1	1	3	2.5
TCE (µg/L)	16	0.3	1	1
cis-1,2 DCE (µg/L)	12	0.3	1	0.2
Vinyl Chloride (µg/L)	1	0.4	1	1
Chloride (mg/L)	180	200	220	230

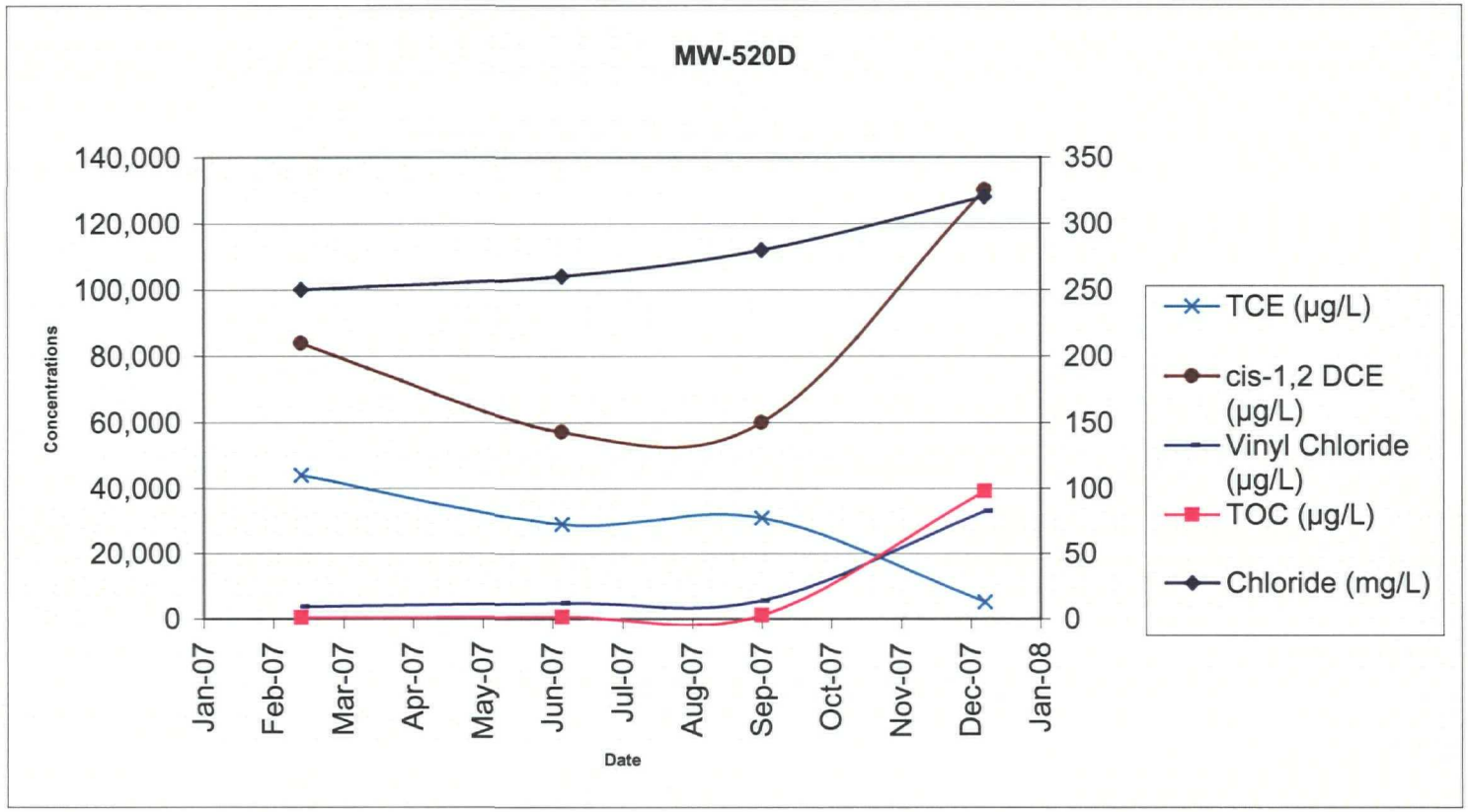
MW-520S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	NS	2.3	19	1100
TCE (µg/L)	4	20	20	2
cis-1,2 DCE (µg/L)	9	2000	220	150
Vinyl Chloride (µg/L)	71	410	490	55
Chloride (mg/L)	NS	110	120	140



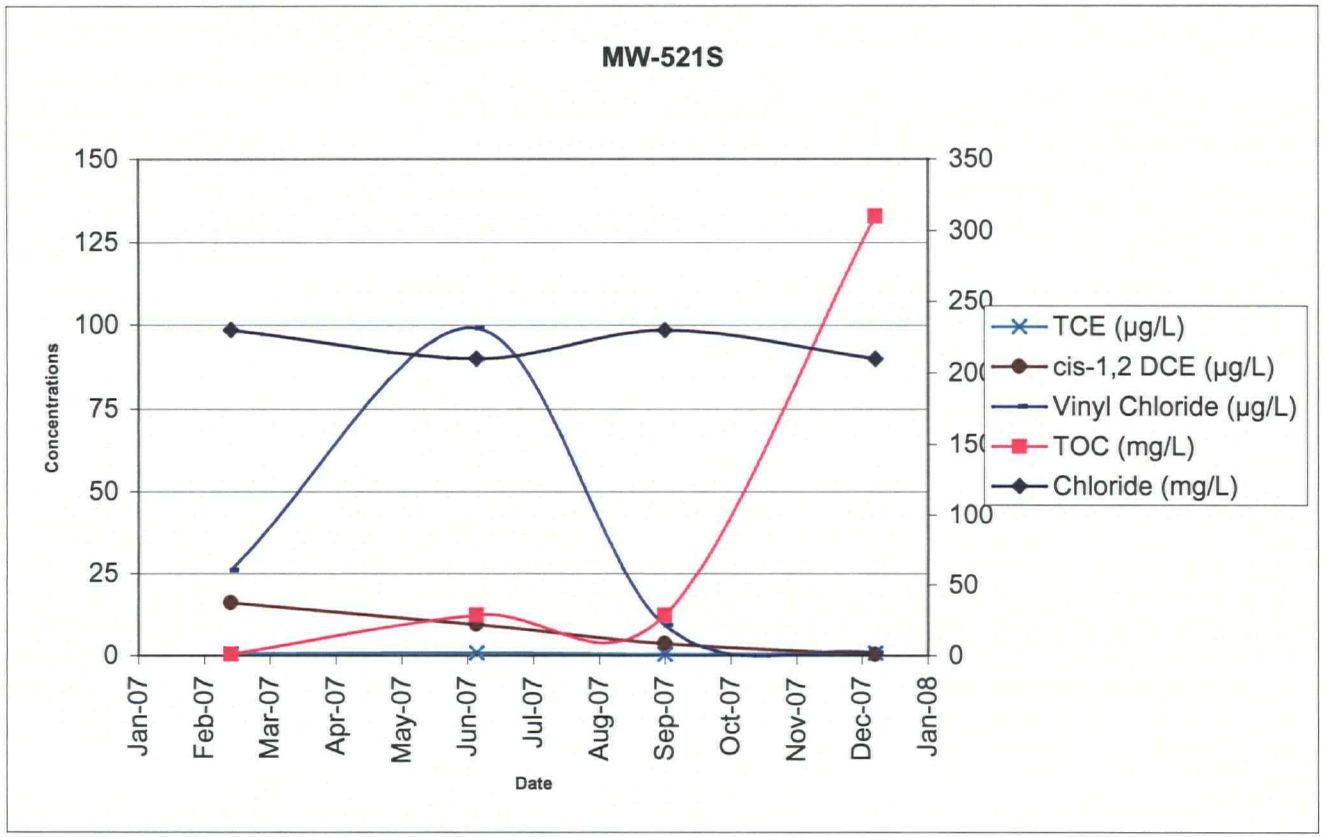
MW-520D

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (µg/L)	1	1.5	3.1	98
TCE (µg/L)	44000	29000	31000	5100
cis-1,2 DCE (µg/L)	84000	57000	60000	130000
Vinyl Chloride (µg/L)	3700	4800	5500	33000
Chloride (mg/L)	250	260	280	320



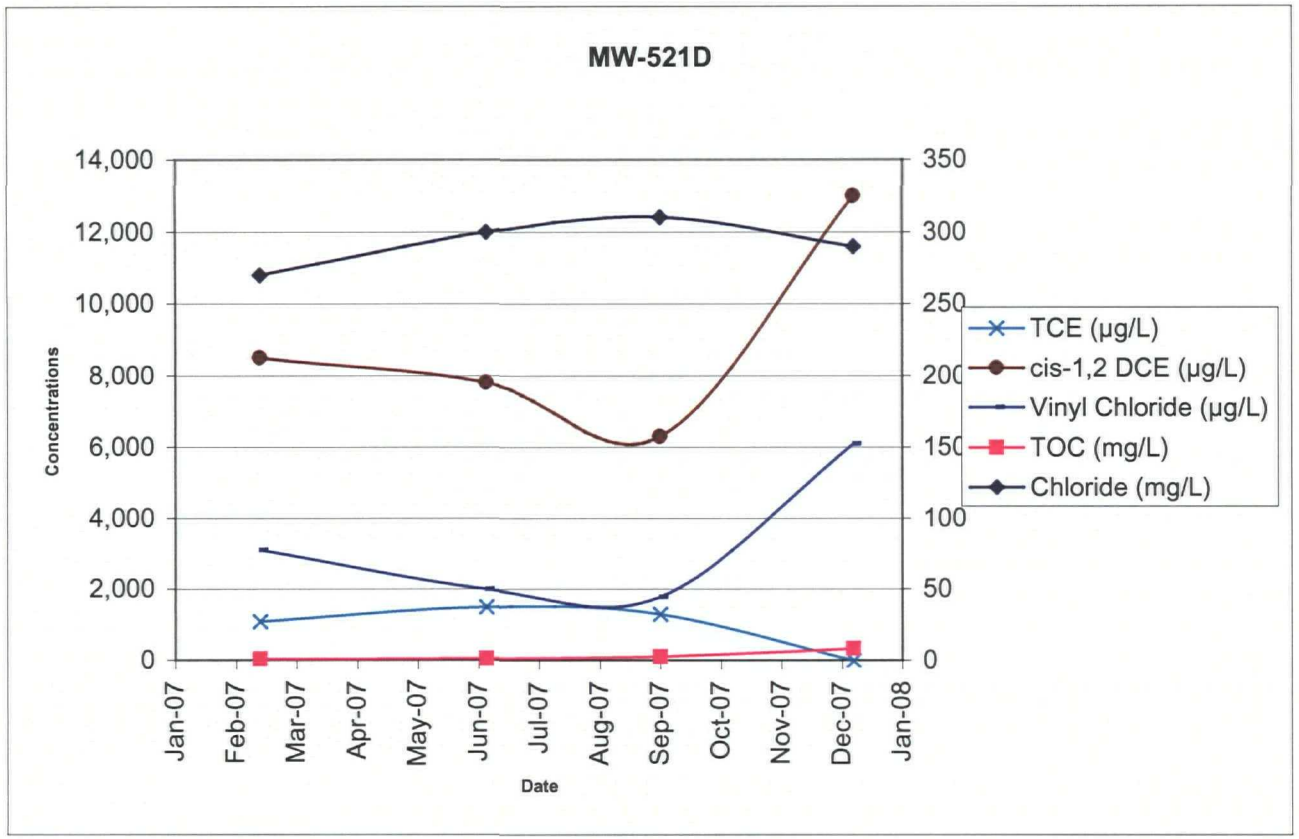
MW-521S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	1	29	29	310
TCE (µg/L)	1	1	1	1
cis-1,2 DCE (µg/L)	16	10	4	0.4
Vinyl Chloride (µg/L)	26	99	9	1
Chloride (mg/L)	230	210	230	210



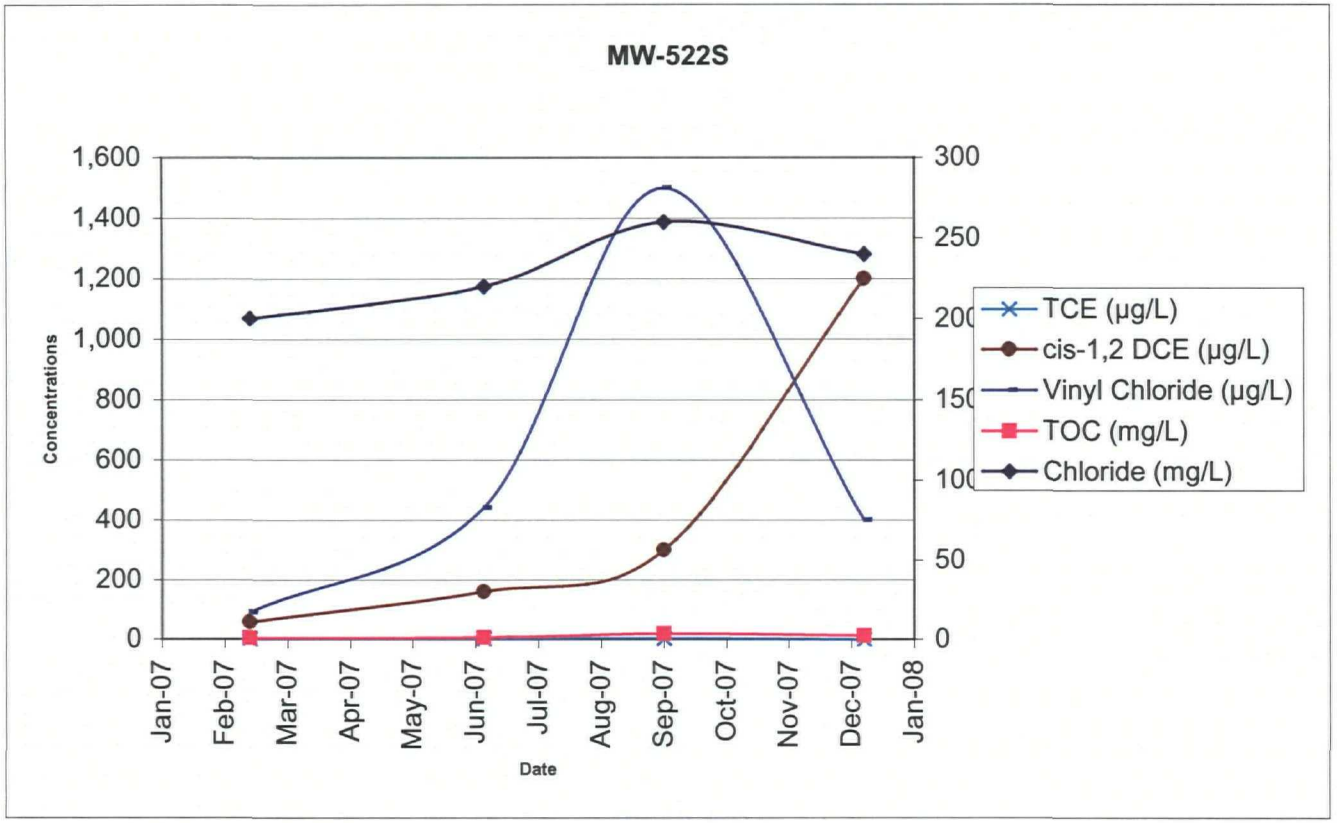
MW-521D

	Baseline **19-Feb-07**	primary **11-Jun-07**	primary **5-Sep-07**	primary **10-Dec-07**
TOC (mg/L)	1	1.4	2.9	8.4
TCE (µg/L)	1100	1500	1300	1
cis-1,2 DCE (µg/L)	8500	7800	6300	13000
Vinyl Chloride (µg/L)	3100	2000	1800	6100
Chloride (mg/L)	270	300	310	290



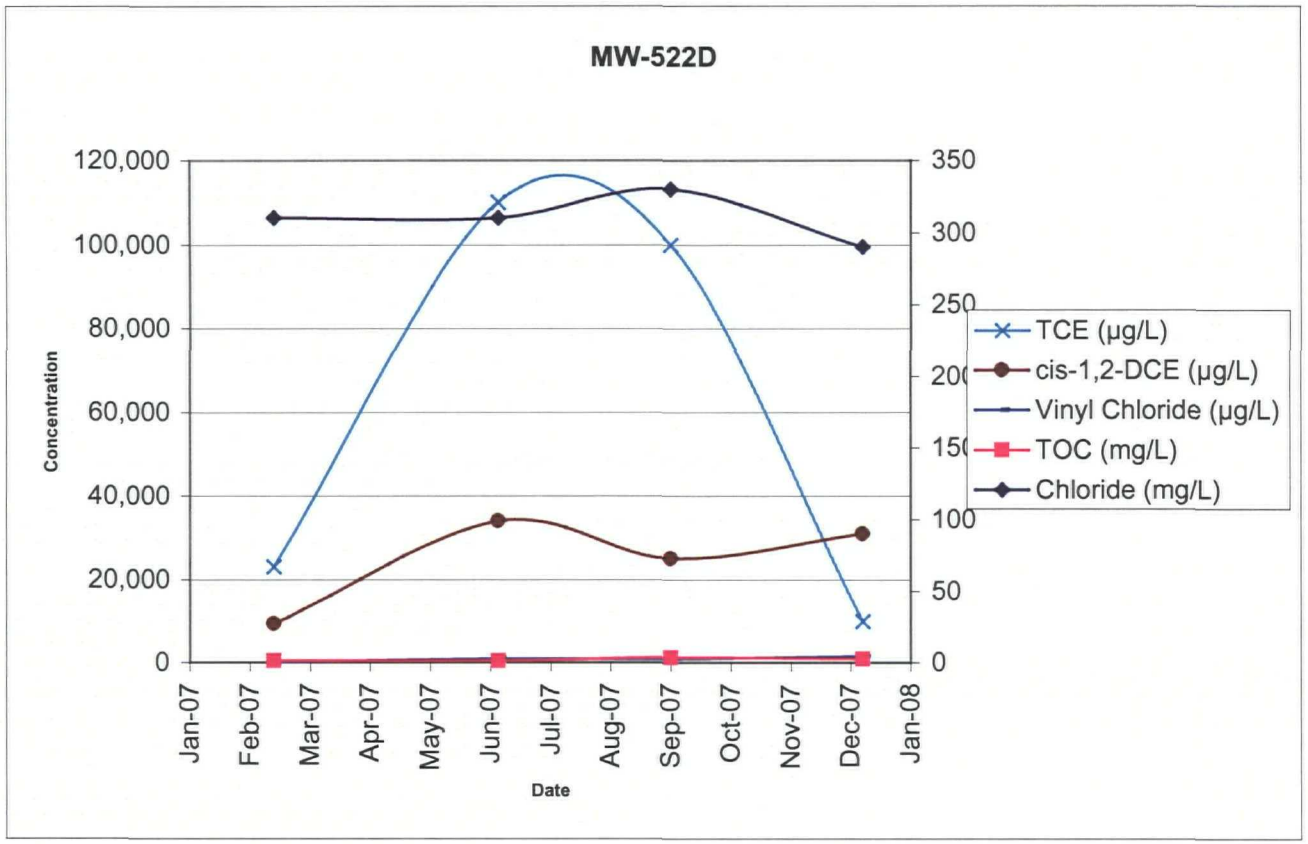
MW-522S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	1	1	3.7	2.3
TCE (µg/L)	3	3	5	1
cis-1,2 DCE (µg/L)	58	160	300	1200
Vinyl Chloride (µg/L)	92	440	1500	400
Chloride (mg/L)	200	220	260	240



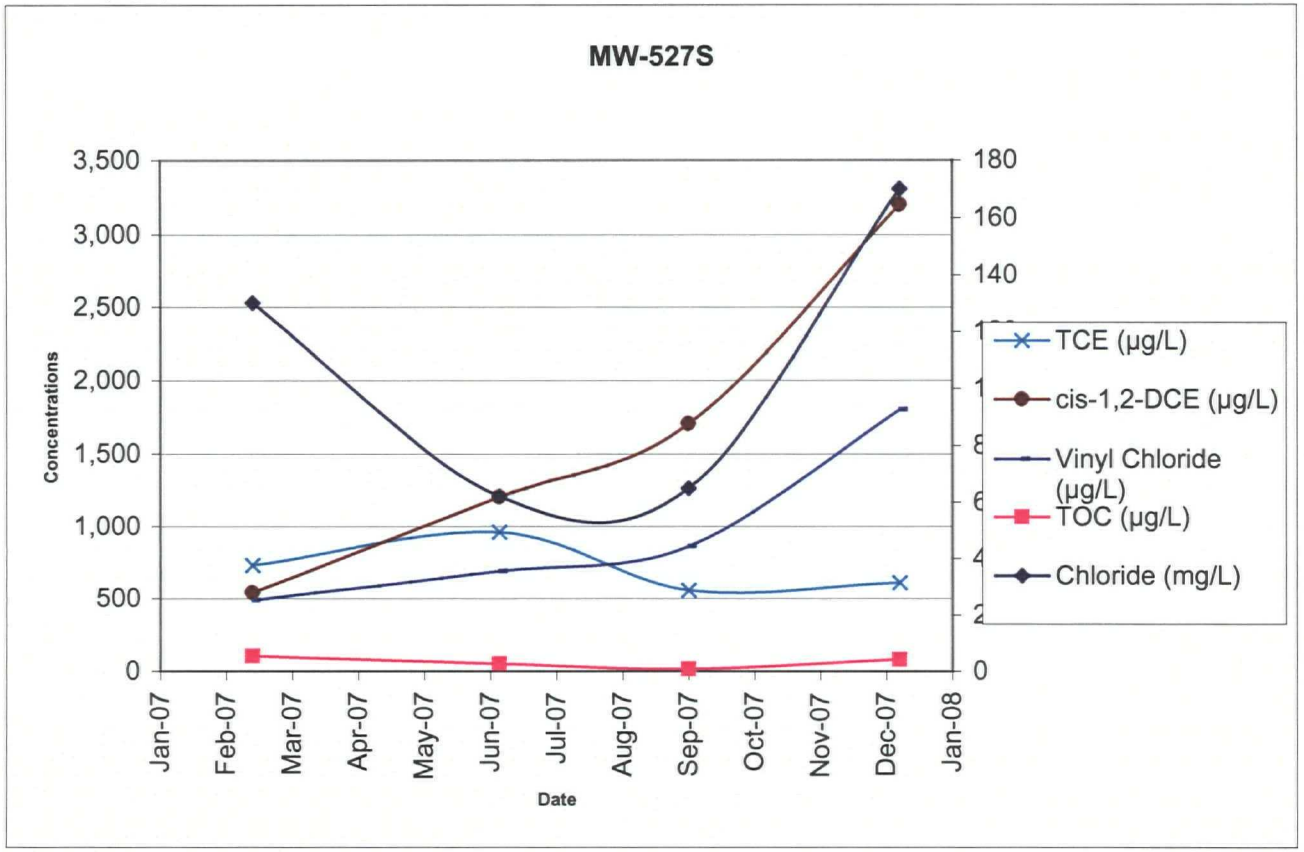
MW-522D

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	1	1.3	3.4	2.5
TCE (µg/L)	23000	110000	100000	10000
cis-1,2-DCE (µg/L)	9300	34000	25000	31000
Vinyl Chloride (µg/L)	200	930	960	1500
Chloride (mg/L)	310	310	330	290



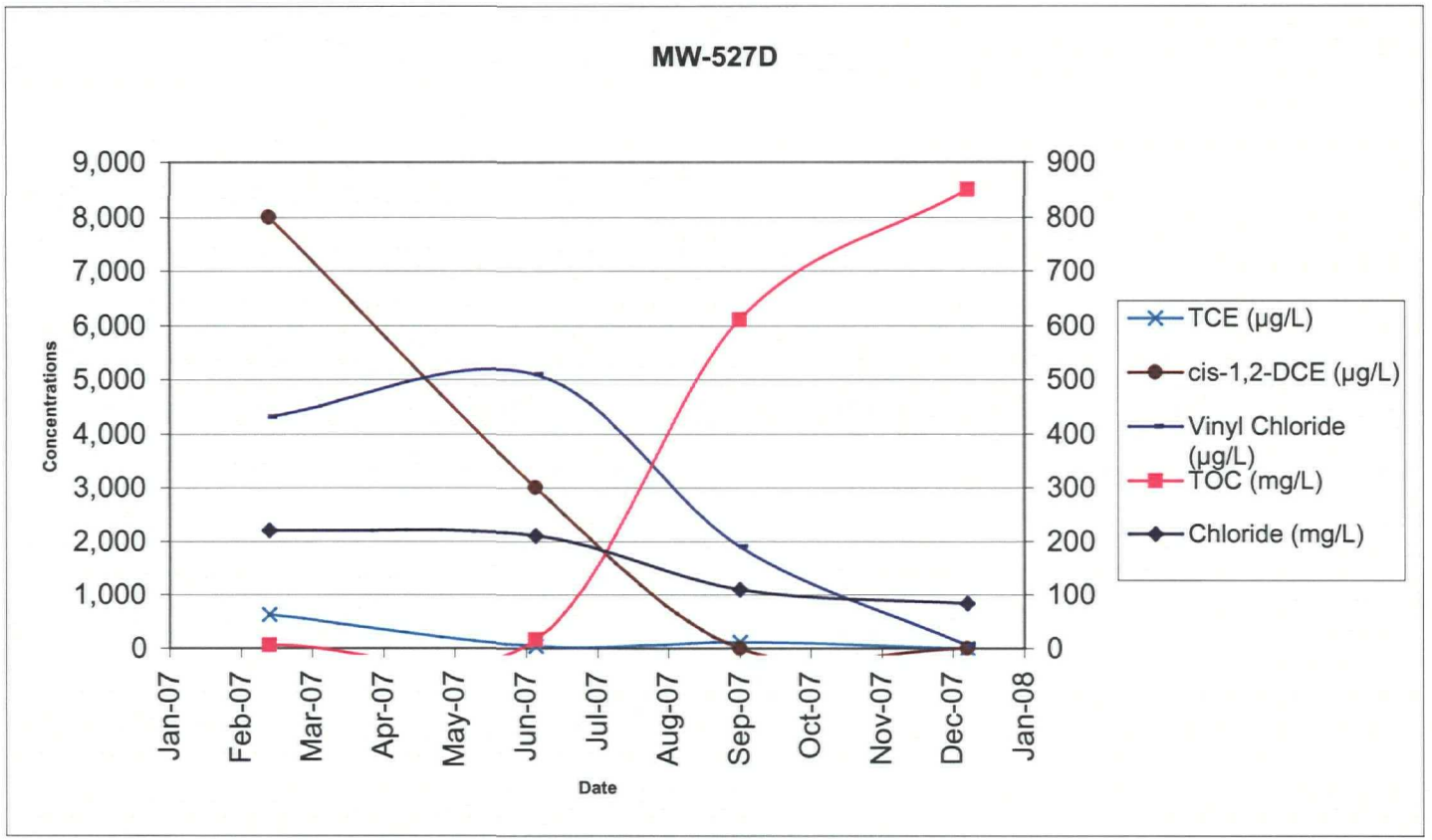
MW-527S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (µg/L)	5	2.8	1	4.4
TCE (µg/L)	730	960	560	610
cis-1,2-DCE (µg/L)	540	1200	1700	3200
Vinyl Chloride (µg/L)	490	690	860	1800
Chloride (mg/L)	130	62	65	170



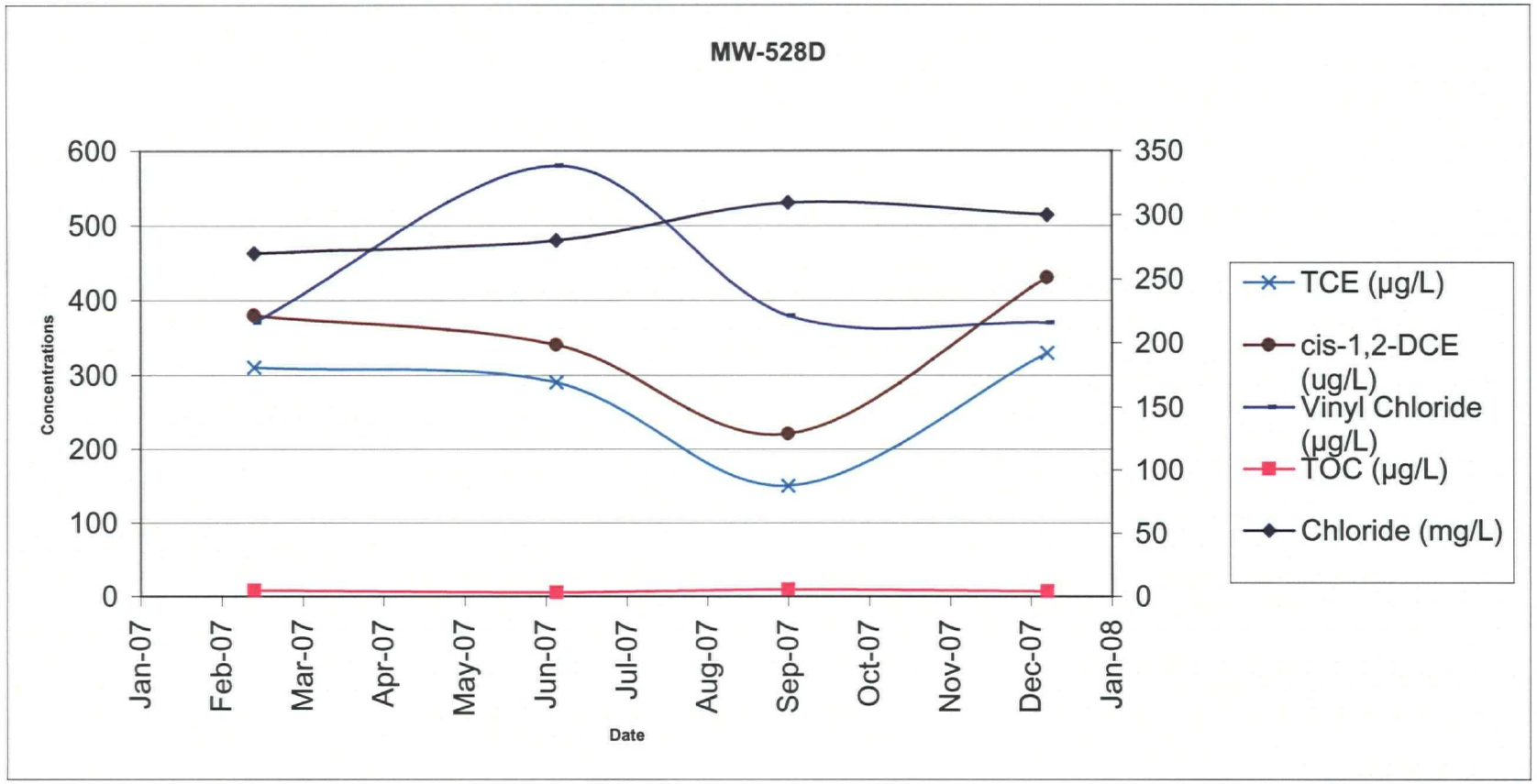
MW-527D

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	6	16	610	850
TCE (µg/L)	630	50	120	1
cis-1,2-DCE (µg/L)	8000	3000	5	3
Vinyl Chloride (µg/L)	4300	5100	1900	58
Chloride (mg/L)	220	210	110	84



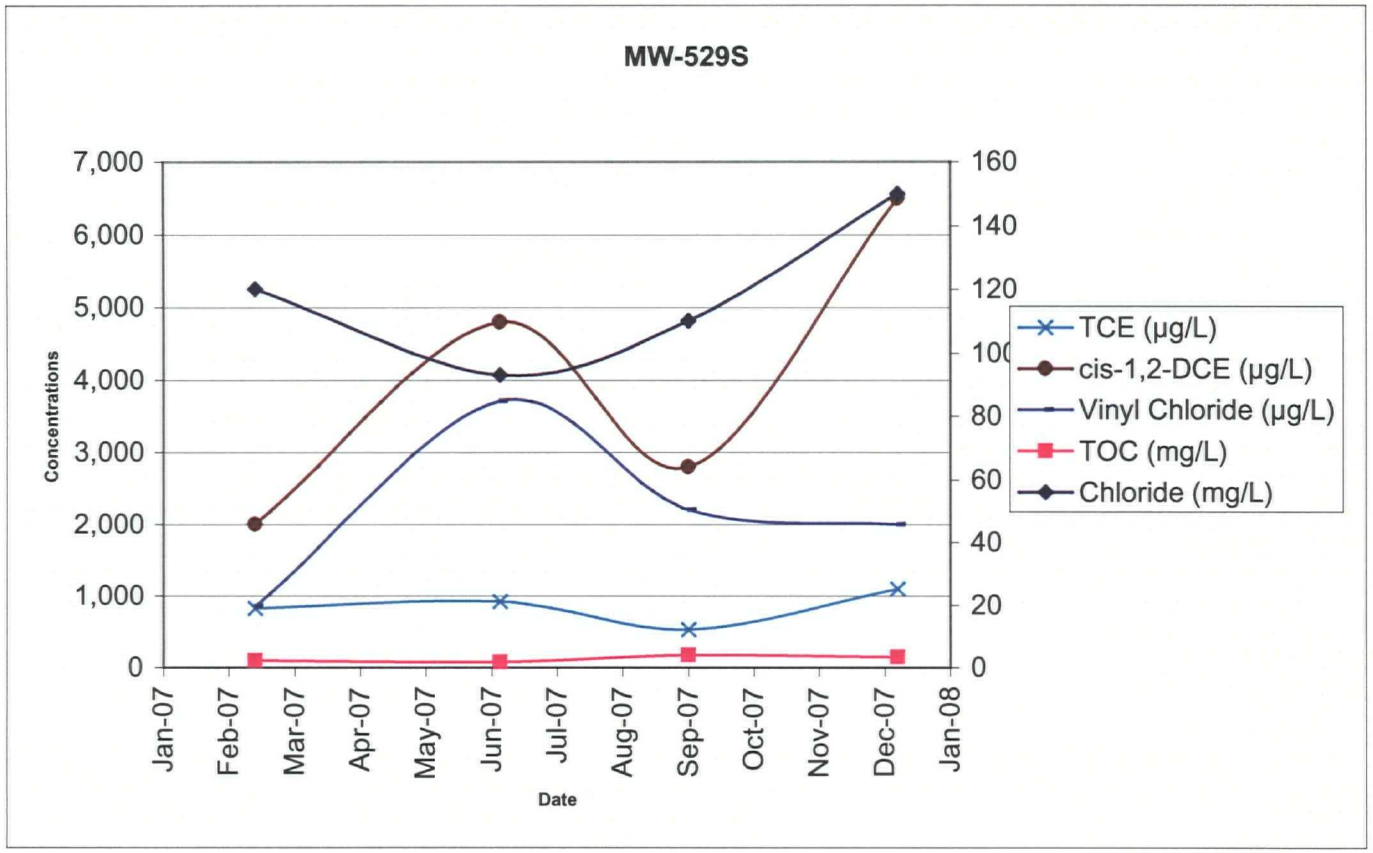
MW-528D

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (µg/L)	4	3.3	5.4	4.2
TCE (µg/L)	310	290	150	330
cis-1,2-DCE (ug/L)	380	340	220	430
Vinyl Chloride (µg/L)	370	580	380	370
Chloride (mg/L)	270	280	310	300



MW-529S

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	2	1.9	4.1	3.5
TCE (µg/L)	830	920	530	1100
cis-1,2-DCE (µg/L)	2000	4800	2800	6500
Vinyl Chloride (µg/L)	850	3700	2200	2000
Chloride (mg/L)	120	93	110	150



MW-529D

	Baseline	primary	primary	primary
	19-Feb-07	**11-Jun-07**	**5-Sep-07**	**10-Dec-07**
TOC (mg/L)	18	4.2	290	46
TCE (µg/L)	99	9	5	1
cis-1,2-DCE (µg/L)	1700	850	480	720
Vinyl Chloride (µg/L)	1500	2500	1700	1600
Chloride (mg/L)	200	210	160	220